UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION I
J.F. KENNEDY FEDERAL BUILDING, BOSTON, MASSACHUSETTS 02203-2211

A Consolidated Report Of
Evaluations and Transactions - -

Indoor Air and Work Place Environmental Qualities. EPA Region 1 Occupied Spaces. One Congress Street. Boston, MA.

N. A. Beddows, CIH, CSP.

February 28, 1991.

A Consolidated Report Of
Evaluations and Transactions - -

Indoor Air and Work Place Environmental Qualities. EPA Region 1 Occupied Spaces. One Congress Street. Boston, MA.

N. A. Beddows, CIH, CSP.

February 28, 1991.

A Consolidated Report Of Evaluations and Transactions - -

Indoor Air and Work Place Environmental Qualities.
EPA Region 1 Occupied Spaces. One Congress Street. Boston, MA.

N. A. Beddows, CIH, CSP.
February 28, 1991.

ABSTRACT

This is a consolidated report and record of previously and separately reported evaluations of indoor air and environmental qualities and related transactions, and new information dealing with employees' assessments or complaints of facility conditions, and perceived or actual medical symptoms, as reported upon by a Public Health Service physician. Also, summary data, for the period of November 1990 to February 1991, on formaldehyde, target volatile organic compounds and illuminance are provided, as appendices.

In August 1990, federal employees moved from The J.F.Kennedy building to nearby One Congress Street, Boston. One Congress Street is a low rise building with eleven floors: garage spaces which are sprinkler protected, on the lower nine levels, and two newly-constructed, sprinkler protected office floors above. Several Agencies occupy space on the office floors. The total occupied space area is approximately 231,000 square feet. The total occupancy is about 1200 people; about 550 occupants are employees of the US. Environmental Protection Agency. The Facility is a no-smoking one. A designated smoking room exists on the tenth floor, for the use of every agency. Ventilation is achieved by a modern variable air volume system with conventional filtration. Offices are both enclosed and open, and are of the usual sizes. For the most part, the floors are very open, and each floor has atrium space in the centers. The furniture is modular in type, manufactured by Herman Miller, Incorporated. The flooring is nylon carpet panels. At installation, the carpet squares were secured using a water based, polyvinyl acetate copolymer adhesive. The wall surfaces were painted using a water-based PVC latex paint. Some wood work and trim were painted or varnished with solvent-bearing preparations.

Formal complaints and several dozen informal complaints were made to the safety office by EPA employees on both floors involving claimed chemical sensitivity or one or more complaints of eye irritation, (upper) respiratory tract irritation, headache, and excessive skin dryness and itching.

In early December, preliminary evaluations were made of the forced ventilation of the work places, ergonomic stresses, carbon monoxide, carbon dioxide, formaldehyde and dust levels. The findings were generally favorable, and were presented at an all-employee meeting on 12/21/90. After the December meeting, work was undertaken to: evaluate target volatile organic compounds (toluene, benzene, di/tri-substituted benzenes, chlorinated alkanes and alkenes, C5 and longer straight chain hydrocarbons, ketones, and alcohols) in the work place; and, establish a medical type questionnaire for the confidential reporting of employees' concerns or complaints to the management, through a public Health Service physician, and a questionnaire to report complaints to the Facilities Branch Chief. Also, other aspects of evaluating indoor air and work place environmental qualities also were considered. These matters are reported on to employees through a supplementary report dated 1/27/91, and a second open meeting.

The summary findings to date are that the ventilation (fresh air in) level is fully satisfactory. However, there are localized problems of thermal balance and air-throw, especially at the corner-wall locations on both floors. There is no infiltration of carbon monoxide from the garages below. Formaldehyde level is consistently low. The level of target volatile organic compounds are consistently low. Dust level is low, and no inorganic fibrous mineral is present in dusts; Lead in drinking water has been tested, and is not a problem. Noise and illuminance are localized problems. Excessive dryness of air is a seasonal problem on both floors. The frequency of complaints formally raised to date is low. Approximately one hundred responses to the medical questionnaire have provided to the occupational physician. Analyses of complaints in these questionnaires will take some time, and will be made available by the physician. Based on the quantitative assessments which we have made, and which are reported herein, the writer believes that there are no recognizable health hazards in the work places.

I. ACKNOWLEDGMENTS.

Dr. Tom Spittler and Mr. Peter Kahn made the on-site analyses of carbon dioxide, carbon monoxide gas and target volatile organic compounds analyses using portable infra-red (Miran) and GC-PID (Photovac) equipment. Dr. Mary Beth Smuts arranged for the initial formaldehyde (passive dosimeter) evaluations, made by the state of Massachusetts.

Mr. Howard Davis provided analyses of supplied dusts. Mr. Robert Wade gave me the lighting survey data. Mr. Jeffrey Davidson, Mr. David Smith and Mr. Julius Jimeno, provided information on materials and outgassing, and helped me by their discussions and comments. Mrs. Barbara White helped in arranging the employee IAQ-survey, as did Dr. Alvero O'Campo, who kindly agreed to confidentially appraise the returned medical questionnaires.

I gratefully acknowledge the truly excellent cooperation and assistance which these colleagues have given me.

Table Of Contents In Order Of Presentation.

Appendix

II. INTRODUCTORY REMARKS.

In August 1990, EPA employees moved from The J.F.Kennedy building to nearby One Congress Street, Boston. Approximately 600 employees and contractors' staff relocated to assigned space of approximately 190,000 square feet.

One Congress Street is a low rise building with eleven floors: garage spaces which are sprinkler protected, on the lower nine levels, and two newly-constructed, sprinkler protected office floors above. Several Agencies occupy space on the office floors. The total occupied space area is approximately 231,000 square feet. The total occupancy is about 1200 people. The Facility is a no-smoking one. A designated smoking room exists on the tenth floor, for the use of every agency. Ventilation is achieved by a modern variable air volume system with conventional filtration. Offices are both enclosed and open, and are of the usual sizes. For the most part, the floors are very open, and each floor has atrium space in the centers. The furniture is modular in type, manufactured by Herman Miller, Incorporated. The flooring is nylon carpet panels. At installation, the carpet squares were secured in place by a partial application of a water based, poly vinyl acetate copolymer adhesive. The wall surfaces were painted using a water-based PVC latex paint. Some wood work and trim were painted or varnished with solvent bearing preparations. This treatment was minimal with respect to surface area. Also, for several months after the first occupancy, part of the eleventh floor was in construction; this part was essentially walled in and off-limits to all occupants.

Shortly after the relocation and for a period of several months, several formal complaints and several dozen informal complaints were made to the safety office by occupants of both floors. These involved two complaints of chemical sensitivity,and a dozen or so complaints of eye irritation, (upper) respiratory tract irritation, headache, and excessive skin dryness and itching.

In early December, the writer began a preliminary evaluation of the forced ventilation of the work places and looked at some aspects of ergonomic stress. Later in the month, evaluations of carbon monoxide, carbon dioxide, formaldehyde, and dust levels were made by T. Spittler, Howard Davis and the writer. These evaluations were reported in a formal report, issued 12/21/90 by the writer. Also, they were presented at an all-employee meeting, held on 12/21/90. The report was made available to all employees in January, 1991.

As a outcome of the December meeting, additional work was undertaken to:

- Evaluate target volatile organic compounds (toluene, benzene, di/tri-substituted benzenes, chlorinated alkanes and alkenes, C5 and longer straight chain hydrocarbons, ketones, and alcohols) in the work place.

- Establish (i) a medical type questionnaire for the confidential reporting of employees' concerns or complaints to the management, through a public Health Service physician, and (ii) a questionnaire to report complaints to the Facilities Branch Chief.

Other aspects of evaluating indoor air and work place environmental qualities also were considered. All of these matters were formally reported in a supplementary report dated 1/27/91, by the writer. The supplementary report was made available to all employees in February, 1991.

The purpose of this consolidated report is twofold. It is to (i) bring together all of the information of the evaluations and transactions which took place in the period from early December 1990 to late February, so that a comprehensive record can be established in one place; and (ii) provide information which may be useful in addressing any future complaints and in other programs for looking at issues of indoor air and work place environmental qualities.

III. INCORPORATED MATERIALS.

The following materials are directly incorporated in this report in order to establish a single, comprehensive record:

- A Summary Report Of A Preliminary Evaluation, 12/21/90.
- Open Meeting Announcement. Meeting Of 12/29/90. With Agenda and Hand-out.
- Report Of A Study Of The Operation & Capacity Of The HVAC System.
- Report Of The Meeting Of 12/29/90.
- Supplementary Report of 1/27/91. An Addendum To The Summary Report.
- Notice Of Update Meeting.
- Report Of Update Meeting.
- View-Graphs Shown In The Update Meeting.
- Letter Of Request To Complete Questionnaires. (1) Medical Questionnaire. (2) Facilities Questionnaire.
- Letter To Occupational Physician.
- Current Information From Questionnaires.
- Copies of Notices.

THE SUMMARY REPORT OF 12/21/90.

A Summary Report of a Preliminary Evaluation. Indoor Air and Work Environmental Qualities. EPA Region 1-Occupied Spaces, One Congress Street. And Identified Opportunities for Improvement.

N. A. Beddows. CIH, CSP.
December 21, 1990

Summary

Information is provided to assist individuals and managers to evaluate indoor air quality, work place environmental qualities, and personal complaints, given adequate data. Included are matters covering: carbon dioxide, carbon monoxide and formaldehyde indoors; ventilation criteria and system extractor sizing for smoking rooms; work place noise and illumination; dust and volatile organic chemicals (VOCs) indoors; associations between VOCs and health and comfort; and claimed chemical sensitivity.

Results of quantitative tests are presented. The levels of carbon monoxide, carbon dioxide, and formaldehyde, together with the evidently low occupant density and other relevant points, indicate that (i) the HVAC mechanical ventilation fresh air supply, and (ii) the air quality in the office spaces are generally fully satisfactory.

Matters of observed localized temperature variations, work place noise and illumination, lighting glare and contrast; and claimed personal discomfort involving irritation of the eyes and upper respiratory tract are discussed. Also, related potential problems are identified. These include: personal practices; physical arrangements, and certain cleaning operations conducted during the mid-morning and later periods (involving the use of strong chemical spray cleaners and "feather-dusting" - with redistribution of any settled dust). Whether or not actual problems exist or will occur, depends on the particular conditions, practices and locations, and the tolerance levels of those who are impacted.

The employer's duty, and prudent actions in responding to complaints are described. And, opportunities which managers and individuals can take to improve work place environmental quality are identified. These relate to localized noise, illumination and ergonomic stressors.

Optional, additional valuative programs are identified. At some later date, management might want to have such programs defined and implemented by outside specialists. To this end, program information is provided. This covers: scope-of-work; project costs and durations; and contractual considerations for assuring cost effectiveness and good work-quality.

Post-script. This report is supplemented by a formal report, dated January 21,1991.

Introduction.

Indoor air and work environment qualities in EPA spaces in One Congress Street have been recent topics of discussion, following on from two noteworthy, separate claims of EPA employees of alleged chemical sensitivity (a term which is described later) and distress when working in open space offices (which are like all the other offices), and about a dozen separate complaints of respiratory irritation, headache, eye strain, backache or irritability, made to the safety manager. Questions about indoor air quality have been raised and points have been made on this matter which appear to now need addressing in a systematic, comprehensive way, in accordance with good industrial hygiene practice. This report attempts to do this at one time and in one place. And, it is intended to serve as a basis and format for considering any future inquiries or proposals which may arise. It is not intended as a response to any particular complaint or any alleged condition or complaint of any employee, although it might be useful in part for this purpose.

Four sections are presented which deal with the following major points, and some others:

A. Background Information. This covers carbon dioxide (CO_2), carbon monoxide (CO), other possible indoor pollutants (dust, volatile/semi-volatile organic compounds, lighting and noise) and ventilation.

B. Test Results. These cover (i) CO_2 and CO test results of tests made on 10/22/90 of EPA spaces by T. Spittler, ESD Laboratory Director;(ii) formaldehyde test results re: tests (eleven in total) of the 10th and 11th floors, made in the November-December period by the writer; and (iii) other pertinent observations and facts.

C. Discussion. Re: reported chemical test results and other observations and facts.

D. Other Matters. These cover (i) the employer's duty; (ii) prudent actions; (iii) opportunities for improvement of work place quality and employee morale, including steps that employees can take directly; and (iv) a statement of scope of work, which may be undertaken in the future at the management's direction, re: chemical targets for analysis, and corresponding program cost estimates for additional, optional technical evaluations.

Some of the points covered in parts C and D relate to comfort or personal productivity. These points are discussed from an industrial hygienist's viewpoint; other people may reasonably disagree with what is said. In these areas, "one man's meat is another man's poison."

Reading these sections in order will be the best way to get an overall impression of the above captioned topic. However, each section stands by itself and can be read without having to refer to any other section, if there is no informational need to do so.

A. Important Background Information

1. Carbon Dioxide Indoors

1.a. Carbon dioxide (CO_2) is a useful index of the adequacy of the supply of outside air to an office environment to maintain healthy and hygienic conditions.

1.b. There is no national official indoor air quality (IAQ) standard re: CO_2 (or for that matter for carbon monoxide and many of the volatile chemicals which are IAQ-factors). There are, however, some formal and informal standards covering these substances which are or may be relevant.

1.c. The DOL/OSHA CO_2 standard includes a permissible exposure limit (PEL) of 5000 ppm. This limit is based on the risk of asphyxiation, not on IAQ industrial hygiene/ventilation needs. The OSHA-PEL has no value as an IAQ-standard.

1.d. Most industrial hygienists would agree that (1) CO_2 concentrations of 600 to 800 parts per million (ppm) are acceptable in a modern office environment, without regard to any smoking therein; (2) a range of 800 to 1000 ppm, while possibly acceptable, would be reason to initiate an investigation and implement appropriate corrective action; and (3) a concentration over 1000 ppm indicates that a potentially serious problem of inadequate outdoor air ventilation or overcrowding exists.

1.e. The ambient air carbon dioxide level is nominally 0.03% by volume, and is seasonally variable.

2. Carbon Monoxide Indoors

2.a. Carbon monoxide (CO) is a sentinel of health hazard arising from infiltration of air contaminated with automobile exhaust gases and other products of combustion.

2.b. The OSHA general industry standard, permissible exposure limit, as an 8 hour time-weighted average, for carbon monoxide is 50 ppm. This standard relates to industrial processes and atmospheres. It has no value as an IAQ-standard. The US. EPA NAAQS for carbon monoxide is 35 ppm for 1 hour, and 9 ppm for an 8 hour exposure; the 9 ppm/8 hour exposure limit is useful as an upper limit re: indoor air quality; it is not a criterion of acceptable, average (IAQ) CO-concentration.

2.c. Most industrial hygienists would agree that (1) a maximum CO concentration, read on a CO-meter or color indicator tube, of one to two ppm would be acceptable in a modern, no-smoking office environment; and (2) any CO concentration greater than two parts per million would be cause to make an investigation of infiltration of contaminated air from a nearby garage or combustion site.

2.d. In a dedicated smoking-room, even with forced ventilation in operation, CO concentrations would be elevated. In this context, considering the physiological effect (blood CO-heme/CO in air equilibrium), and the feasibility of using forced ventilation, CO concentrations greater than 10 ppm are unacceptable, in the writer's judgment.

The carbon monoxide level (and smoke particulate - the far greater chronic health hazard) should be maintained as low as practicable using forced ventilation with direct outside exhaust.

3. Ventilation, and CO Standard for a Smoking-Room

3.a. Ventilation conditions which the writer would impose as a standard are: at least (i) 150 cubic feet of force-supplied air per minute per smoker, supplied by a low-noise level fan, and (ii) an air velocity of 150 feet per minute at three feet above the floor, at the room center, without regard to any use of an electrostatic or charged-ion smoke capture device. As an example of such ventilation, a 20'x25'x10' smoking-room (maximum of 10 people) would be ventilated (at 18 volume changes/hour) with air supplied at a minimum at a rate of 1500 cfm. To achieve this (with a low, 2" of water total pressure, duct/entry/friction HVAC-type loss, 15 foot run of 1 sq. ft. area duct to the exterior), a ([1500 x 2]/[6350 x 0.7 (m.e.)]) nominal 3/4 H.P. (with a slightly greater than required flow) axial flow fan would be used, preferably in a push-pull arrangement. The duct-hood area would be sized and positioned to get the 150 foot velocity, according to the circumstances.

3.b. A maximum concentration limit of five ppm in a smoking-room is proposed by the writer. And a goal of one ppm is proposed, based on a personal assessment of an engineered option.

4. Noise Indoors

4.a. There is no known risk of experiencing any type or degree of hearing impairment, nor any other known health risk of any other type arising from indoor office noise at the usual levels in offices.

4.b. Noise in the work station which varies in level and/or pitch is believed to be a factor of both the sense of personal well-being and productivity; freedom from disturbance is important to employees.

4.c. The use of masking or "white" (variable frequency/similar sound pressure level in each frequency) noise is no longer credible (but background music may have a place in some areas).

4.d. Carpeting is used by acoustical engineers as a way to acoustically treat a room.

5. Illumination Indoors

5.a. Illumination, glare and contrast lighting at the work station are factors of the sense of well-being, and productivity. A minimal level of (i) illumination (50 ft-cdle?) and (ii) a minimal value (3?) of (task-background) luminance ratio is necessary for reading comfort. Inferior illumination and excessive glare are believed to cause eye strain and headache; and, they may contribute to ergonomic stresses.

5.b. Indirect lighting of adequate uniform level is much preferable to direct lighting in looking at video screens. When direct overhead lighting is used in offices,, optical diffusers (plastic lens) should be used for comfort; large (6" square) open metal grid "diffusers" in office locations may be found by some people to be allow too much of the lighted fluorescent tubes to be seen directly, causing excessive glare. Also, a soft yellow light is easier to read in than a hard white light (the eye is optimally sensitive to yellow).

5.c. The quality of direct lighting at work surfaces depends on (i) the type of lighting (diffuser lens on fluorescent lights reduce direct glare); (ii) the height, distribution and angularity of the fixtures, and (iii) the luminance (task-background) differences. Work place shadow pattern is an indicator of quality.

5.d. Detail work (drawing, mapping) may need at least 100 ft-cdle. of illumination at the task surface; a general office requires lighting levels at desk surfaces of at least 50 ft-cdle., and some people would find this level to be marginal for their needs.

5.e. The OSHA safety illumination standard (at 29CFR 1910/1926), 30 ft-cdle for offices, is marginal for reading and working in a modern office setting.

5.f. An ANSI standard (ANSI-11.1, 1973) provides luminance and luminance ratio guidelines which are relevant, but possibly conservative. These guidelines are useful for assessing office area and task lighting quality.

6. Dust Indoors

6.a. It is well known that fibrous asbestos, silica dusts, and dusts laden with pathogens can pose significant health hazards. However, these types of dusts are not expected to be present in new offices.

6.b. Benign dusts may be found to a varying extent in a modern office environment, however, there is no recognizable health risk with such dusts in such a setting.

7. Volatile and Semi-Volatile Organic Chemicals Indoors.

7.a. It is well known that the classes of volatile and semi-volatile organic chemicals known as (1) aldehydes, (2) aromatic hydrocarbons and (3) aliphatic cyclic-hydrocarbons include compounds which are capable of causing local minor irritation

hydrocarbons include compounds which are capable of causing local minor irritation (eye, respiratory tract) to some people at/above some low (a few parts per million) threshold level, with relatively short (a few hours) exposures. These classes of compounds exist, together with a host of other compounds of different classes, such as ketones, alcohols, alkanes, chlorinated alkanes and alkenes, to a varying and trace extent indoors.

7.b. These and other compounds arise from construction pressboard (e.g., formaldehyde); carpets (e.g., formaldehyde, 4-phenylcyclohexene, acetone); carpet adhesives (e.g., toluene, benzene, styrene, acrylonitrile); and industrial cleaners (e.g., 1,1,1, trichloroethane, tetrachloroethylene, methylene chloride, ethoxylated 2nd alcohols, ethylanolamine, butoxyethanols).

7.c. The use of solvent-containing cleaners in office spaces, especially at the start of the work shift can add significantly to the indoor contaminant level; this burden can be persistent throughout the day. The use of such products is to avoided. If they must be used, they should only be applied after regular hours or controlled as to application times.

7.d. Users must be instructed in the safe and proper use of chemicals, and material safety data sheets (MSDS's) must be made available to users, under both federal and state "Right To Know " laws.

8. Personal Detection Limits For IA-VOCs.

8.a. Most of the compounds referenced at section 7.a have characteristic odors, and can be (subjectively) detected by odor and/or local irritation (eye blinking), at a few parts per million concentration. Some strongly irritating compounds (dienes, mercaptans, aldehydes) can be detected similarly at or below a part per billion concentration. Formaldehyde (and some other VOCs) irritate ones eyes and respiratory (URT) at less that the corresponding odor detection threshold concentration (which is a fractional part per million).

9. Formaldehyde in Newly or Recently Furnished Office Spaces

9.a. Formaldehyde may be present in (and diffuse from) new furniture, depending on the construction materials used. It may exist in offices at concentrations which cause eye irritation or respiratory distress to some occupants. The peak concentration will depend on the particular emissivity (temperature dependent!) of the furniture pieces in the case, the number of pieces in place, the ventilation turn-over time (the reciprocal of the air exchange rate) and other factors. With passing time, the concentration of formaldehyde (and any other VOC) in the furnished, ventilated space will decrease in a logrithmic fashion.

9.b. A significant percentage (10 - 20% ?) of the population are hypersensitive to formaldehyde. Hypersensitivity to formaldehyde and other haptens may be demonstrated using standard Type 1 allergenic tests (direct skin; RAST); and, in some cases, by a respiratory air flow restriction, as measured by $FEV_{1.0}$ spirometry.

NOTE. People of ordinary sensitivity may experience irritation of the mucosa upon short-term exposure to formaldehyde at concentrations which they may be unable to detect by its distinctive, pungent odor.

9.c. The (i) average-person's (approximate) odor detection limit, and (ii) the action level is 0.05 ppm (50 parts per billion).

9.d. IA-formaldehyde measurement can be made inexpensively using a 7-day passive dosimeter in conjunction with the universally used, chromatropic acid-spectrographic analytical method. A slightly more expensive but more accurate (reported resolution, 5 ppb; CV = 10%, claimed) method, based on passive dosimetry with DNPH-HPLC (2,4-dinitrophenylhydrazine reagent, with high performance liquid chromatography), is available from the GMD Co., Hendersonville, PA. 412 742-3600. This company also makes/analyses toluene diisocyanate (TDI) dosimeters, for use in evaluating urethane foam-rubber "outgassing" problems.

9.e. The 7-day exposure/chromatropic acid, passive dosimeter's limit of detection is reported to be 20 parts per billion. This should be interpreted carefully because such limits are inherently imprecise and tend to be measured under optimum developmental conditions. A factor of five (?) or more may be appropriate to apply to the reported limit of detection, when reviewing data close to the claimed limit of detection. An interesting corollary, given the reported odor detection limits, is that a person with a sensitive smell for formaldehyde may be able to grossly classify indoor air, in terms of the formaldehyde action level (0.05 ppm), with about the same accuracy as a passive (chromatropic acid chemistry) dosimeter, while other persons may not smell it.

9.f. The outdoor air formaldehyde level is approximately 0.005 ppm (MA-DPH data).

9.g. Testing office spaces for formaldehyde (and also for organic diisocyanates: TDI, MDI), and conducting differential spirometry on affected employees, should be considered when upper respiratory tract (URT) irritation is reported by employees who work in newly/recently furnished spaces.

10. Analytical Instrumentation Sensitivity.

10.a. The analytical instruments now in use have such good sensitivity that many of these (i.e., those listed in 7.b.) compounds and some tens or hundreds of other organic chemicals may be detected or measured at a few parts per billion, and lower levels. Accordingly, many organic compounds may be shown to be present in trace amounts, indoors, when modern analytical instruments are employed.

11. Associations (Re: Comfort, and Well-Being)

11.a. A range of 72 to 80 degrees (F), with a corresponding range of 45 to 50 percent relative humidity (an indicator of how much of the maximum retainable water exists in the air) is the recognized comfort range for office type activities and occupancies. As the temperature within the range increases, the percentage of relative humidity must reduce to maintain equivalent personal comfort. Low relative humidity (e.g., 15% -20 % R.H.) causes and/or contributes to (i) the condition known as "dry eye", and (ii) URT-irritation.

11.b. The association between the presence of volatile organic chemicals, at parts per billion concentrations, and health or comfort appears to be largely unknown. However, a 1985 study by L. Molhave et al, in Denmark has shown that a mixture of hydrocarbons which are known to be common indoor air pollutants will cause eye, nose and throat irritation in healthy adults, which is not adaptable, at an exposure of: concentration of approximately one part per million (measured as toluene; GC-FID); duration 2 3/4 hours. Accordingly, total volatile organic compound level, "measured" as toluene, by GC.FID, at about 1 ppm is considered by the writer to be the very outside upper limit for offices. One should apply an uncertainty (safety) factor of at least 10 to "set" an upper limit for permissible hydrocarbon contamination, in the writer's judgment.

12. Outgassing and Diminution In a Ventilated Building ("Airing-Out").

12.a. It is known that volatile compounds which are or may be initially present in new office furnishings and carpeting "outgas." Some kinetic studies using environmental chambers have shown that out-gassing of volatile compounds in new carpeting in a simulated force-ventilated office type environment follow first order kinetics, and the compounds are relatively short-lived, having half-lives in terms of weeks. If this is the general case, continual airing out by the continuous operation of a HVAC system would be expected to result in the virtual elimination of offending volatile compounds present in new carpeting and furnishings in a period of about two months.

12.b. It is now (well reported) common practice to "air-out", and sometimes "bake-out", volatile organic compounds from a new office facility by operating the HVAC system for one or more weeks before the offices are occupied. Its value is negated by a daily use of solvent-containing cleaners.

13. Other IAQ-Factors.

13.a. Oxides of nitrogen and sulphur, and biological entities are potential contaminants, but normally they are not concerns in new office buildings; they are concerns in older homes and other constructions which use gas for cooking, or coal for heating. Ozone is a concern in some (enclosed, high-activity) copying operations which are not force ventilated directly to the outside.

13.b. Volatile organic compounds (including formaldehyde) can not be directly removed from circulating air using a high efficiency particulate (HEPA) filter, as is sometimes asserted.

14. Claimed "Chemical Sensitivity" and the Indoor Office Environment

14.a. A highly controversial issue currently exists with respect to "chemical sensitivity of no known etiology" and people being affected or claiming to be affected, in some way, in some indoor situations. This type of situation is distinct from those involving those conditions which are fully recognized to exist, affect perhaps 20% of the population, and have a known etiology (such as IgE-mediated allergic response of asthma with re-exposure to methylene diisocyanate; hay fever, from pollen).

Some medical authorities, while obviously recognizing immunity as a basis for allergies, and that chronic low exposures to chemicals might interfere with normal cellular activities or damage cells, suggest that some claims are likely to have a psychological component (e.g., anxiety panic). Some others who are similarly aware of the immunologic aspects appear to content that it low level chemical exposures invariably are responsible for some claimed "chemical sensitivity' effect.

14.b. A few volatile/semi-volatile organic chemicals (dienes, aldehdydes) which may occur in some offices and homes environments are evidently capable of acting as local irritants at low (parts per billion) concentrations, and they may act systemically in some known mechanistic way at somewhat higher levels. However, the notion that chemicals at **trace** concentrations universally act singly or in concert in some currently unknown mechanistic way to adversely affect the health of, or incapacitate, individuals in general, as appears to be the case made by some doctors, is disputed by many allergists and other medical clinicians. Some experts express difficulty in seeing a diagnostic significance to such claims, and question the value of on-going, lifetime-duration "shot" treatments (versus periodic/seasonal drug treatment) which some doctors prescribe.

14.c. Without commenting further on the issue of chemical sensitivity, it is noted that in a modern office, which has been constructed and furnished, and is operated, so as to minimize a burden from volatile organic compounds, the quality of the (filtered and exchanged) air is superior to many home environments in regard to aldehydes, hydrocarbons, formaldehyde, and oxides of nitrogen, sulphur and carbon (which are common pollutants from kitchens with gas cookers), molds, animal dander, and cigarette smoke, when smoking occurs. Also, old, uncleaned carpeting and furnishings, wherever they are found, are reservoirs of a host of animate and inanimate allergens.

B. Results of (1) CO_2/CO, and (2) Formaldehyde Tests. Other Observations.

1. CO_2, CO Tests.

1.a. Dr. Tom Spittler, ESD laboratory director, tested the EPA-occupied office spaces on the 10th and 11th floors, and the 10th floor smoking-room for CO_2 and CO concentrations. The tests were made on 10/22/90 in the late morning and mid-afternoon period (for specific values, please refer to Dr. Spittler's summary report of 10/25/90).

1.b. The maximum CO_2 concentration reported for any office space was 360 ppm. Also, the average of the reported CO_2 levels is comparable to the outside level.

1.c. The maximum CO concentration reported for an office space was 0.9 ppm.

1.d. The CO concentration reported for the 10th floor smoking-room (when it was occupied by five people who were smoking - about half-full, and when the two "smoke-eaters" were in operation, as observed by the writer) was 5 ppm.

2. Formaldehyde Tests

2.a. The 10th floor was tested quantitatively for formaldehyde in the first week of November.
The writer's open-floor plan office (10-319) and a closed type office (10-364) were tested using a passive dosimeter which was exposed for 160 hours, during a normal work period which included a week-end period. The MA state DPH made the analyses (which were kindly arranged for by Dr. Mary Beth Smuts, of the EPA Region 1, Air Toxics and Pesticides Division). The MA-DPH reported results, as simple average values for the 160 hour sample time, as follows:

OPEN OFFICE AREA (10-319): 0.018 part per million.

CLOSED TYPE OFFICE (364): 0.023 part per million.

Other Observations

3.a. General Indoor Conditions, and Some Localized Reported/Observed Problems.

(i) There is no discernible general chemical odor, nor new carpet odor, nor formaldehyde odor in any of the EPA-office spaces.

(ii) Several complaints of eye irritation and having to leave the area after the janitors clean the Information Center (usually in the morning around 9 a.m.) with a spray-cleaner have been made. The cleaner used is 3M's "Trouble-Shooter."

(iii) Ozone is detectable by odor in the 10th floor copying room during intensive periods of copying, and in the computer room during the initial operation of the Laser-printer.

NOTE:

o The presence of trace amounts of ozone at the time when cleaning solvents are used (as has been observed by the writer) may increase the risk of acute eye irritation in the computer room, via either actual products of reaction of the pollutants (peroxy organic compounds: strong eye irritants) or by an additive or synergistic effect.

(iv) There is no discernible surface dust in the offices. However, this observation is only directly relatable to coarse, visible dusts; it does not relate to, but it may parallel, fine dust which is not directly visible but which is respirable (10 micron and smaller) particulate. No information on indoor respirable dust (PM10) is available.

(v) Air temperatures are generally very comfortable, but some localized insolation problems in August were reported for the atrium areas and in the south-west corner of the 11th floor. At the time of the problems the HVAC system on the 11th floor was being worked on by the owner. This problem may become a seasonal issue. Installation of translucent sun-screens in the atrium areas and on selected windows on both floors would probably eliminate evident insolation problems.

(vi) Humidity, and more particularly air dryness, is an important component of comfort and the condition of the eyes, nose and throat. This is an unknown factor at this time. As in any office, it might be a seasonal concern.

(vii) Illumination level and "open- grid" fluorescent lights have been mentioned as a problem by some employees, who describe the problem as one of feeling the need to wear eye-shades (visors).

NOTES:

- Light fixture placement has been mentioned as a reason for the perceived poor level of lighting in some situations. Dark carpeting and furnishings in areas remote from the atrium may require being off-set by additional overhead lighting, and/or repositioning of existing fixtures for balance.

- Direct lighting can cause direct and indirect glare. Indirect area lighting - which is less efficient electrically but is more comfortable - for example, upwardly directed, shielded wall-lights, is beneficial in office areas. Recent (ergonomics) literature references the preference for office indirect lighting in computer (PC) operation.

(viii) Noise propagation in the building is a concern to some employees in some locations. Reportedly, some employees use ear-muffs (which may be radios) at their work stations.

3.b. Work Station Conditions.

(i) Excessive noise intrusion and lack of business privacy have been mentioned as problems in some areas of both floors. Personal practices, computer printers, and the current physical/structural arrangement appear to be about equally responsible for at least some of these problems.

(ii) High pitched noise from certain printers (e.g., the Epson LQ 1050) when operating outside of a noise reducing hood (which are available in-house) in open areas (especially in the atrium spaces) is very intrusive and possibly disturbing to many employees.

(iii) Direct glare, and lighting contrast, especially in offices in the atrium area offices, are concerns. Some anti-glare screens are being used in some of the problem areas.

(iv) Physical stresses (back, neck, hand and eye), related to posture and work positioning in using computers, have been mentioned as a concern by some employees.

NOTES:

- Hoods can be used (and required to be consistently used) to control such noise generators.

- 200 anti-glare attachment screens (CURTIS Ltd. MA., manufacturer) were made available in the last week of November. The usefulness of the screens with respect to current concerns is not completely established; however, one of these screens used by the writer does reduce the glare and improve contrast in a major way in the particular situation.

4. Extent and Seriousness of the Expressed or Evident Concerns.

4.a. The concerns described in section C.3.a. are reported on the basis that at least one EPA employee has made a relevant comment to the safety manager.

4.b. Comments have been made as a part of the complaints of headaches, eye or throat irritation, irritability, and backache.

4.c. The actual or perceived extent and seriousness of complaints is not currently known; the comments or complaints made to the safety manager have been relatively few, and only an informal survey has been made. An EPA protocol to formally assess concerns is available.

C. Discussion

1. HVAC-Ventilation

1.a. The ventilation level of the EPA-occupied office spaces is evidently fully adequate to ensure that CO_2 concentrations do not rise above an acceptable level, based on the reported tests of 10/22/90.

1.b. Based on the current level of volume/occupancy (in excess of 1000 cubic feet per person) and the reported CO_2 levels, the supplied outside air ventilation rate per person is estimated (N.A.B) to be not less than about 8 cfm per person, using information in the "Industrial Ventilation" handbook (in this case, the carbon dioxide level / ventilation / occupancy density - curves did not allow any higher value to be estimated).

1.c. The level of ventilation throughout the open office spaces is judged by the writer to be adequate to ensure (i) the required oxygen content; (ii) the prevention of CO_2 concentrations from rising over about 500 ppm; and (iii) the removal of objectionable body and furnishing-type chemical odors which might otherwise be present.

1.d. "Legionella" is not considered to be a risk; the HVAC cooling-intake does not involve, and is not in proximity to, pooled or sprayed water.

2. Formaldehyde.

2.a. The reported results of (the November, 1990) tests for formaldehyde and the evident absence of its distinctive odor indicate that there is no problem of formaldehyde in the 10th or 11th floor offices.

3. Reason for the Perceived Current Absence of General Chemical Odors.

3.a. There is no discernible persistent odor of volatile organic compounds of the type which characterize new furnishings in any of the open office spaces, and none is expected because: (i) no urethane foam backed partitions nor any organic solvent-based paints were used in the installation; (ii) carpet tiles which had very little odor when they were new were used instead of carpet stock in rolls which appear to hold on to the distinctive smell of new rolls of carpet; (iii) only a water-based poly vinyl acetate (PVA) glue was used with the carpeting, and not all of the carpet tiles required gluing down (they mechanically lock in-place in the lay-down); and (iv) the building was aired out before occupancy occurred for at least three weeks, using the HVAC system, after the carpet tiles and the office furnishings were installed.

3.b. Notwithstanding the absence of a persistent general chemical odor of the new furnishing type, cleaning chemical-odors (and associated acute eye irritation) exist at times in the Information Center, as observed by the writer.

4. Specific Matters and Appropriate Responses.

4.a. Reported concerns and evident matters.

(i) Concerns raised by employees are: (1) intruding noise and sound transmission and resulting lack of privacy; (2) illumination and glare in some spaces; (3) illumination of working surfaces and shadowy office lighting and (4) glare, contrast lighting, and placement at the computer -- causing eye strain, backache and neck-ache.

(ii) Some of these types of concerns may be associated with chronic health risks, and they are all associated with comfort.

(iii) With neither excessive indoor noise nor inferior indoor general lighting is there any basis to think that any threshold shift in aural or visual acuity would occur. However, certain physical discomforts and localized interferences with business privacy and productivity exist locally and need resolving.

(iv) Minimal dust and minimal noise in a large, carpeted office are mutually exclusive; a balance is needed, based on the facts, recognizing that carpeting is needed for noise control.

4.b. Appropriate responses to specific matters and situations.

(i) Volatile/semi-volatile Organic Compounds: as mentioned previously, aldehydes, alcohols, substituted cyclo-aliphatic compounds, and other classes of organic compounds which have been associated with some known offending furnishing materials often have odors which can be detected by people at sub-part per billion levels. When there is no chemical odor or a significant level of complaints of eye or respiratory tract irritation in the offices, and when materials were selected with a view to not having volatile organic compounds released into the work place (as in this case), it seems that conducting a broad total volatile organic analysis would not be necessary; however, spot checks in areas could be useful.

If a preliminary analysis were to be required for any reason in such a situation, it would not be expensive. Such testing might not yield information that would be useful to an industrial hygienist, given the current scarcity of acute low dose-response information on many compounds.

(ii) Benign Dusts: as mentioned, there is no visually observable surface soiling or dusting currently in any of the EPA office spaces. Absent visual evidence of dust or a significant level of employee complaints of respiratory irritation there would not seem to be any need to undertake to classify or characterize particulate in air in the office spaces (such an undertaking would be relatively inexpensive and short-term).

(iii) Daily "feather-dusting" is less preferred than vacuuming.

4.c. Employer's Duty.

(i) The relevant (by reason of an Executive Order) and applicable employee health and safety regulation on duty is the OSHA general duty clause [at 29 CFR.1910(5)(a)(1)]. This requires the employer to provide work and work places free of recognized hazards.

(ii) The OSHA General Duty standard does not impose a duty to conduct special investigatory tests or scientific research when a hazard is not recognized to exist by a competent industrial hygienist, after a comprehensive inquiry has been made.

4.d. Prudence of Responding by Undertaking Special Studies.

(i) Not withstanding the absence of a duty, it will be prudent to undertake special studies (VOCs; Lighting; Computer use & use conditions) in some circumstances. The likely benefits (meaningful data) and costs would need to be considered beforehand.

D. Possible Opportunities.

1. Current Factors/Conditions, and Ongoing Occurrences.

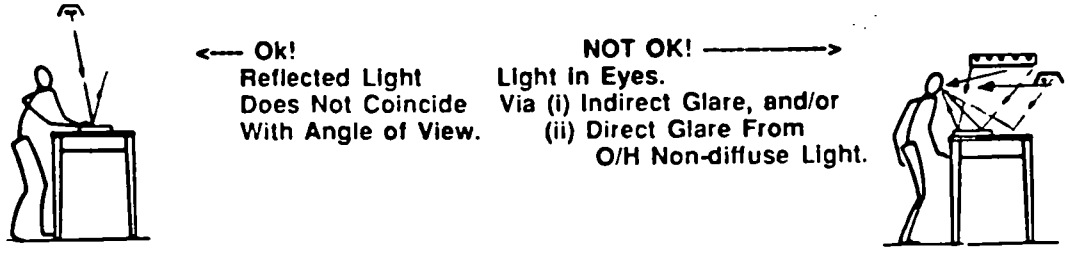
1.a. Selectively retro-fit diffuser lens to ceiling lights where glare is a major problem.

1.b. Use a yellow (Cellophane) filter on (the outside of) the cabinet lights for material-reading comfort.

1.c. Use an anti-glare (PC) screen to reduce eye strain and fatigue.

1.d. Use (flat-black) desk-pads to reduce desk level glare, and improve reading comfort.

1.e. Arrange (i) relative positions, and (ii) lights to prevent or **minimize** (a) reflected glare from desk lights, and (b) direct glare from O/H lights with no open,small-grids or optical lens (see the following diagram).



1.f. The use of organic chemicals for cleaning, and cleaning using organic chemicals in the mornings, as opposed to evening cleaning, are evident candidates for improving the work environment. Prohibiting the use of chemical cleaning agents during regular hours in the computer room -information center should lead to improved air quality and work place comfort.

1.g. The 10th floor copying room is a candidate for improvement (isolation-ventilation).

2. Team and Specialist Making Evaluations.

2.a. Matters of employee complaints of nuisance noise, lack of privacy, insolation, illumination, computer-work visual and postural stresses might be investigated by an EPA team to (i) identify problems, and (ii) propose needed and justified changes to practices and/or physical arrangements or equipment.

2.b. After an initial investigation by the team, specialists could undertake preliminary technical evaluations. The specialists involved would be chosen for competence in acoustical engineering, industrial lighting, and industrial hygiene, as appropriate.

2.c. The use of specialists to perform preliminary evaluations, in accordance with the approach described above, would be relatively inexpensive, and costs could be completely controlled, if a fixed fee, best technical effort-type contract were to be established in every case.

2.d. Formaldehyde indoors could be measured accurately (CV = 15% ?) using the DNPH-HPLG/passive dosimeter method. Testing, if deemed required, could be made on short notice. COST (for 20 tests): $1000. TIME: 5 WEEKS.

2.e. Temperature and humidity meters could be installed (so as to be in full view of the employees) on both floors. COST: $1000. TIME: 4 WEEKS.

3. Individual Efforts For Improving The Work Place Environment.

FOR LOCALIZED NOISE CONTROL: The following suggestions are offered:

- MINIMIZE GROUP DISCUSSIONS IN OPEN OFFICE AREAS. DO NOT HOLD EXTENDED CONVERSATIONS "OVER" PARTITIONS, ACROSS OR IN AISLES OR THE ATRIUM.

- KEEP TELEPHONES ON "LO", AND KEEP CONVERSATIONS etc., AT REASONABLE SOUND LEVELS - TALK LIKE YOU WANT TO KEEP IT CONFIDENTIAL. USE TELEPHONES FOR BUSINESS ONLY. AND, KEEP CONVERSATIONS BRIEF.

- ARRANGE FOR ACOUSTICAL TREATMENT OF (WALLS AND CEILINGS OF) SELECTED OFFICES TO REDUCE SOUND TRANSMISSION.

- POST "PLEASE KEEP THIS AREA QUIET" SIGNS, AS MAY BE NEEDED.

- RESPECT OTHER PERSONS' NEEDS.

FOR CONTROL OF VISUAL AND ERGONOMIC STRESSES: These steps may help:

- ADJUST CHAIR HEIGHT TO MINIMIZE (1) GLARE/CONTRAST, AND (2) POSTURAL PROBLEMS.

- USE SUPPLEMENTARY LIGHTS IN POOR LIGHTING SITUATIONS.

- USE AN ANTI-GLARE SCREEN; ADJUST SCREEN POSITION FOR OPTIMUM COMFORT.

- USE A YELLOW FILTER ON THE OUTSIDE OF THE LENS OF THE DESK LIGHTS.

- USE A BLACK DESK PAD FOR IMPROVED CONTRAST AND COMFORT IN READING.

- WHEN USING A PC, TAKE FREQUENT BREAKS -- REST YOUR EYES; STRETCH YOUR BACK AND NECK MUSCLES, AND SHAKE YOUR WRISTS AND FINGERS TO RELAX THEM.

- SUPPORT YOUR LOWER FOREARMS IN FRONT OF THE KEY BOARD (A 20" x 6" x 3/4" FOAM PAD WILL BE USEFUL WHEN PLACED AT THE LEVEL OF, AND ABOUT TWO INCHES FROM, THE KEYBOARD. CONTROL FINGER IMPACT FORCES. PERIDICALLY DO RELAXATION EXERCISES.

4. Scope of (Optional) Work (applicable to each specialty)

4.a. In the event that an additional, optional, preliminary study is required involving all of the specialties likely to be used (acoustical engineering; industrial lighting; air quality evaluation; and industrial hygiene/epidemiological assessment), the scope of the work for each contract could be limited to the following elements: (i) establish targets and methodology, in conjunction with the industrial hygienist; (ii) make a preliminary evaluation; (iii) report observations; (iv) classify findings; (v) identify opportunities for changes; and (vi) report and recommend.

5. Identification of Chemical/Other Targets, and Methods.

5.a. The organic compounds listed in A.7.b., and some others including chlorinated aromatic compounds, would comprise the target compounds for the purpose of the preliminary evaluation described in 4.a.,above.

5.b. The chemical analytical schemes and methods, and the physical testing in the case of an acoustical investigation which might be used would be established by the Industrial Hygienist in consultation with the respective specialists who would be engaged.

6. Preliminary Evaluation Program - Cost and Duration

6.a. The initial total worth for the combined contracts, as described above, could be set at $40,000, if the management agreed with the described approach, and authorized the work.

6.b. A ten week-long period should be sufficient for completion of this program.

6.c. A second phase of investigation of some particular IAQ-component might be necessary after the preliminary results have been evaluated.

7. Informative Meetings with Employees.

7.a. A lunch-time, employee information session to (1) explain the analytical findings reported herein; (2) inform employees of good personal practices which will minimize work place stress and fatigue and improve the working environment (as identified in section D.3, herein); and (3) address relevant concerns and questions, which our employees and other occupants may have, could be held sometime in mid-december.

7.b. Other agencies in the building might want to have their employees participate.

8. End Notes & Comments.

8.a. Employees can make improvements in the environmental quality of the work place by giving due consideration to personal practices. And, managers must involve themselves in administrative and engineered efforts to achieve optimal work place quality.

8.b. IAQ checks using measured CO2 and CO should be made periodically, and whenever the level of employee complaints suggests the need.

8.c. Given that some percentage of the population at large appears to be especially sensitive or susceptible to airborne chemicals (for instance, it appears that perhaps 20 % is hypersensitive to formaldehyde), whenever there is an actual IAQ-problem one would expect to "see" a corresponding level of specific complaints - not merely a few assorted ones - from a large (several hundred) and vocal occupant population.

8.d. Individuals who need medical help for some condition or suspected allergy may want to ensure that the treating physician is fully trained in allergy - one who has passed the examination administered by the American Board of Allergy and Immunology.

APPENDIX

1. NOTICE OF OPEN MEETING
2. PROPOSED AGENDA
3. ADVISORY NOTICE - WAYS TO IMPROVE THE WORK PLACE ENVIRONMENT.

OPEN MEETING ANNOUNCEMENT.

MEETING OF DECEMBER 21, 1990.

AGENDA & HANDOUT

OPEN MEETING

An Evaluation Of The Indoor Air and Work Environment Qualities Of EPA Spaces At One Congress Street"

*** INVITED SPEAKERS ***

Norm Beddows, Health and Safety Manager, EPA Region 1.
Janis E. Carreirro, RA, DOL-OASAM.
Julius Jimeno, Director, EPA-OHSS.
Pat Meaney, ARA, EPA Region 1.
Tom Spittler, Laboratory Director, EPA-Lexington Laboratory.
Dr. Ocampo, Medical Director, Div. Occ. Fed. Occ. Health, PHS.
Barbara White, National President, AFGE-Union.

Date---------- DECEMBER 21
Time---------- NOON to 1:30
Place---------- EPA 11fl. Conference Room.
One Congress Street.

Information will be presented to help managers and individuals to evaluate: indoor air quality; work place environmental qualities, and personal complaints, given adequate data. Included in this are matters covering: carbon dioxide, carbon monoxide and formaldehyde indoors; ventilation criteria and system extractor sizing for smoking rooms; work place noise and illumination; dust and volatile organic chemicals (VOCs) indoors; associations between VOCs and health and comfort; and chemical sensitivity.

Results of quantitative tests will be reported. The significance of the found levels of carbon monoxide, carbon dioxide and formaldehyde, occupant density, other relevant points, and evident opportunities will be discussed.

AGENDA - 12/21/90. NOON - 1:30.

MODERATOR - PAT MEANEY

PRESENTATIONS

INTRODUCTION -	5 MIN.	PAT M.
EPA CONCERNS -	5 MIN.	JULIUS J.
DOL CONCERNS -	5 MIN.	JANIS C.
EMPLOYESS CONCERNS -	5 MIN.	BARBARA W.
CARBON MONOXIDE & CARBON DIOXIDE -	10 MIN.	TOM S.
FORMALDEHYDE -	5 MIN.	NORM B.
CHEM. SENSITIVY, & RECENT CLAIMS -	15 MIN.	Dr. O

PANEL - ABOVE NAMED

Q&A PERIOD (40 MINUTES OR AS REQUIRED).

TO EMPLOYEES -- EFFORTS YOU MIGHT MAKE TO IMPROVE YOUR WORK ENVIRONMENT

FOR LOCALIZED NOISE CONTROL. The following suggestions are offered:

- MINIMIZE GROUP DISCUSSIONS IN OPEN OFFICE AREAS. DO NOT HOLD EXTENDED CONVERSATIONS "OVER" PARTITIONS, ACROSS OR IN AISLES OR THE ATRIUM.

- KEEP TELEPHONES ON "LO", AND KEEP CONVERSATIONS etc., AT REASONABLE SOUND LEVELS. TALK CONFIDENTIALLY.

- MIMIMIZE THE USE OF TELEPHONES; AND KEEP CONVERSATIONS BRIEF.

- ARRANGE FOR ACOUSTICAL TREATMENT OF (WALLS AND CEILINGS OF) SELECTED OFFICES TO REDUCE SOUND TRANSMISSION, WHEN PRIVACY IS CRITICAL.

- POST "PLEASE KEEP THIS AREA QUIET" SIGNS, AS MAY BE NEEDED.

- RESPECT OTHER PERSONS' NEEDS.

FOR CONTROL OF VISUAL AND ERGONOMIC STRESSES. Take these steps:

- ADJUST CHAIR HEIGHT TO MINIMIZE (1) GLARE/CONTRAST, AND (2) POSTURAL PROBLEMS.

- USE SUPPLEMENTARY LIGHTS IN POOR LIGHTING SITUATIONS.

- USE AN ANTI-GLARE SCREEN; ADJUST SCREEN POSITION FOR OPTIMUM COMFORT.

- USE A BLACK DESK PAD FOR IMPROVED CONTRAST AND COMFORT IN READING.

- WHEN USING A PC, TAKE FREQUENT BREAKS -- REST YOUR EYES; STRETCH YOUR BACK AND NECK MUSCLES, AND SHAKE YOUR WRISTS AND FINGERS TO RELAX THEM.

- SUPPORT YOUR LOWER FOREARMS IN FRONT OF THE KEY BOARD (A 20" x 6" x 3/4" FOAM PAD WILL BE USEFUL).

- CONTROL FINGER IMPACT FORCE IN STRIKING THE KEYS.

- PERIODICALLY, LIGHTLY MASSAGE YOUR FINGERS AND WRISTS.

REPORT OF STUDY OF OPERATION & CAPACITY OF THE HVAC-SYSTEM

JANUARY 15,1991

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

REGION I

J.F. KENNEDY FEDERAL BUILDING, BOSTON, MASSACHUSETTS 02203-2211

SOME COMMENTS ON THE ACTUAL VENTILATION (DESIGN, OPERATION, CAPACITY, AND RELEVANT STANDARDS) OF THE HVAC SYSTEM, and PERCEIVED COMFORT - EPA OCCUPIED SPACE, ONE CONGRESS STREET, BOSTON, MA

N.A. Beddows

1/15/91

THE FOLLOWING COMMENTS AND POINTS ARE BASED ON THE WRITER'S OBSERVATIONS, DISCUSSIONS ON THE HVAC SYSTEM IN USE, INFORMATION PROVIDED BY THE BUILDING MANAGER, AND A REVIEW OF INITIAL WORKING DRAWINGS. THEY ARE NOT BASED ON ANY STUDY OF "AS-BUILT" DRAWINGS, SINCE THESE EITHER DO NOT EXIST OR ARE NOT CURRENTLY AVAILABLE TO THE WRITER.

A. ACTUAL VENTILATION

1. INTERIOR VARIABLE AIR VOLUME (VAV) UNITS ARE FIXED CAPACITY, BUT DIFFER IN SIZE RANGING FROM 800 - 3250 CFM. THE MEDIAN NUMBER UNIT CAPACITY IS STATED BY THE BUILDING MANAGEMENT TO BE 1000 CFM. OUTSIDE AIR AND CHILLING OF THIS AIR ARE HANDLED BY 8 FIXED AIR MOVERS ON THE ROOF CONNECTED, VIA DUCTS, TO THE VAV UNITS.

2. FOR EACH VAV UNIT, OUTSIDE AIR FLOW RATE AND RECIRCULATING AIR FLOW RATE ARE (CONSTANTLY) VARIABLE AND CONTROLLED BY TEMPERATURE AND FLOW SENSOR FEEDBACK. AT ALL TIMES OF OPERATION, A MINIMUM FLOW RATE OF OUTSIDE AIR ENTERS EACH VAV UNIT IN OPERATION. THIS INTAKE IS SET SO AS TO BE NOT LESS THAN 20% OF THE CONSTANT SUPPLY AIR RATE, OF THE RESPECTIVE VAV UNIT, GOING TO THE SERVED SPACE. THIS PROVISION CAN BE VERIFIED (AND HAS BEEN SELECTIVELY CHECKED BY THE WRITER) FROM THE SYSTEM COMPUTER TERMINALS FOR EACH AND EVERY VAV UNIT.

3. A TOTAL OF 168 VAV UNITS COMPRISES THE INTERIOR AIR SUPPLY AND AIR HEATING PORTION OF THE TOTAL SYSTEM. AT ANY ONE TIME IN A WORKDAY, MOST (90%) OF THE VAV UNITS OPERATE SIMULTANEOUSLY.

4. THE ENTIRE HVAC SYSTEM SERVES A CURRENT COMBINED POPULATION OF APPROXIMATELY 1200 PERSONS OCCUPYING TWO FLOORS WITH A COMBINED AREA OF 225,000 SQUARE FEET.

5. USING CONSERVATIVE VALUES OF RELEVANT FACTORS, THE WRITER'S ESTIMATE OF DAYTIME MINIMAL VALUE OF CURRENT OUTSIDE AIR SUPPLY RATE -VENTILATION- PER PERSON IS [(1000 x 0.2 x 0.9 x 168)/1200] 25.2 CFM PER PERSON. ALSO, THE WRITER'S ESTIMATE OF THE CURRENT AIR EXCHANGE RATE IS "NOT LESS THAN 4 CHANGES PER HOUR" FOR THE ENTIRE FACILITY.

6. THE 1989 ASHREA "VENTILATION FOR ACCEPTABLE INDOOR AIR QUALITY" STANDARD #62-1989, AT TABLE 2.2, "INSTITUTIONAL FACILITIES -CLASSROOMS, LIBRARIES, AUDITORIUMS", REQUIRES A MINIMAL VENTILATION RATE OF 15 CFM PER PERSON (LOW-RISE OFFICE VENTILATION IS NOT SPECIFICALLY ADDRESSED). THIS REQUIREMENT IS BASED ON ATTAINING COMFORT, AND CONTROLLING ODOR AND CARBON DIOXIDE LEVELS TO ASSURE AN ADEQUATE MARGIN OF SAFETY AND HEALTH.

7. EPA GUIDANCE (NOW IN DRAFT FORM ONLY) REFERENCES THE VENTILATION REQUIREMENT IN THE ASHRAE 62-1989 STANDARD.

FIGURE 1 ILLUSTRATES THE BASIC VAV UNIT CONFIGURATION.

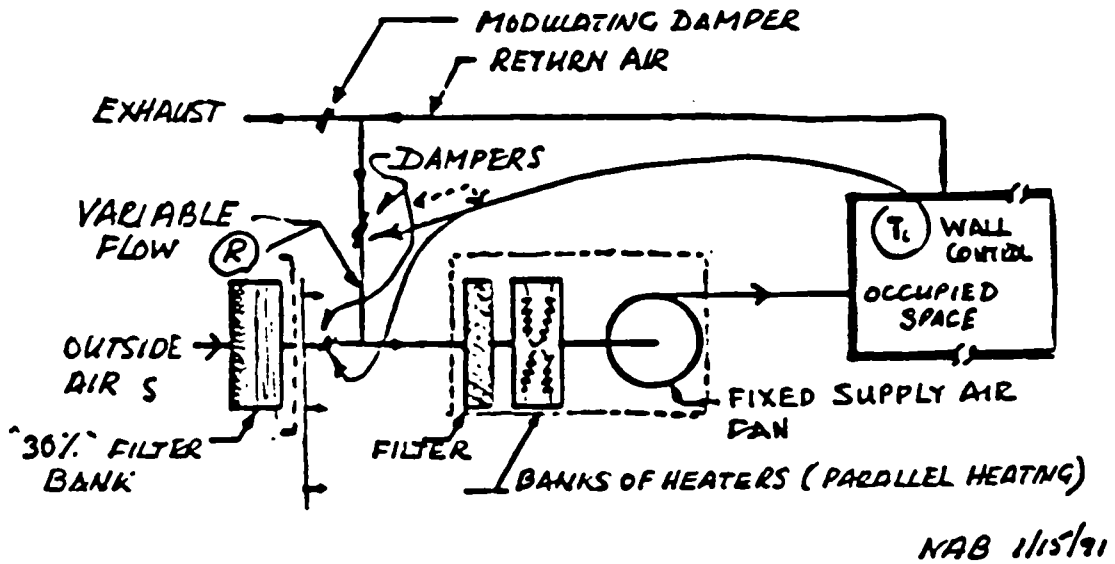


FIGURE 1. BASIC VAV CONFIGURATION.

BASED ON THE ABOVE MATTERS OF ACTUAL VENTILATION, AND WITH DUE REGARD TO OTHER STUDIES (i.e., carbon dioxide, carbon monoxide, formaldeyde) REPORTED ON 12/20/90, THE WRITER BELIEVES THAT THE ACTUAL VENTILATION AT ONE CONGRESS STREET, EXCEEDS (BY 160%, IN THE CASE OF OUTSIDE AIR PER PERSON SUPPLY) THE VENTILATION RATE NEEDED FOR HYGIENE FOR THE CURRENT LEVEL OF OCCUPANCY. ALSO, THE WRITER JUDGES THE INTERIOR SPACES AND THE VENTILATION SUPPLY AIR TO BE CLEAN, BASED ON DUST TESTS MADE IN EARLY JANUARY BY THE WRITER (REPORTED ON SEPARATELY IN A JANUARY REPORT PRESENTED AS AN ADDENDUM TO THE DECEMBER 21, 1990 IAQ-REPORT.

B. COMFORT LEVEL

1. IN THE FIRST AND SECOND WEEKS OF JANUARY, NUMEROUS COMPLAINTS OF BEING COLD WERE RECEIVED FROM EPA EMPLOYEES, ESPECIALLY THOSE LOCATED IN EPA (and DOL) OFFICES ABUTTING THE SOUTH-WEST WALLS OF BOTH FLOORS.

2. IN SOME OFFICES, THERE APPEAR TO BE PROBLEMS OF (i) A COLD DRAFT FROM ABOVE HEAD HEIGHT LEVELS, AND (ii) SIGNIFICANT, I.E., GREATER THAN 4-5 DEGREE (F) DIFFERENCE, TEMPERATURE GRADIENTS, FROM DESK TOP TO FOOT LEVELS.

3. TEMPERATURES IN THE ELEVATORS HAVE BEEN RATHER FRIGID. AT TIMES, LARGE AREAS OF THE FLOOR AREAS ADJACENT TO THE ELEVATORS HAVE BEEN FRIGID.

4. TEMPERATURE SETTINGS ARE SET FROM CONTROLLERS MOUNTED AT 4 FOOT HEIGHTS ON THE WALLS. HOWEVER, THE COLD IS MOST KEENLY FELT, ACCORDING TO THE COMPLAINANTS, AT FOOT LEVEL.

5. THE NET EFFECT IS PERCEIVED BY MANY TO BE DISTINCTLY UNCOMFORTABLE, AT THIS TIME.

6. IT IS WELL ESTABLISHED IN INDUSTRIAL HYGIENE THAT PERCEIVED COMFORT RELATES TO AIR MOVEMENT, ROOM (DRY BULB) TEMPERATURE, AND RELATIVE HUMIDITY. ALSO, AS RELATIVE HUMIDITY FALLS (AS OFTEN HAPPENS IN WINTER MONTHS), TEMPERATURES MUST BE INCREASED TO MAINTAIN EQUIVALENT COMFORT LEVEL.

7. BASED ON LONG STANDING ASHRAE CRITERIA FOR COMFORT FELT BY THE MAJORITY (97%), AT ANY EXTENSIVELY (I.E., 3 HOURS/DAY) EXPOSED PART OF THE BODY, WHEN ROOM AIR MOVEMENT IS IN THE NORMAL RANGE OF 15 -25 FEET PER MINUTE (AND BEARING IN MIND THAT RELATIVE HUMIDITY OFTEN CAN BE 30 %, OR LOWER, INDOORS IN OFFICES, IN THE WINTER MONTHS), ONE WOULD WANT TO "SEE" THE TEMPERATURE AT THE EXPOSED SKIN LEVEL TO BE ABOUT 72 DEGREES F.

8. SINCE THE SENSORS ON THE WALLS ARE SHIELDED FROM DRAFT AND EVEN NORMAL AIR TURBULENCE (WHICH COULD ACTUALLY BE AT RELATIVELY LOWER TEMPERATURE - OF COURSE, THERE IS NO CHILL FACTOR INVOLVED WITH INSTRUMENTATION) AND THEY ARE PLACED AT LEAST THREE FEET HIGHER THAN FOOT LEVEL, AND SINCE SIGNIFICANT TEMPERATURE GRADIENTS EVIDENTLY EXIST BETWEEN DESK TOPS AND FOOT LEVELS, AT LEAST IN SOME OFFICE LOCATIONS, THERE IS AN EVIDENT NEED TO SET SOME WALL UNIT CONTROL TEMPERATURES HIGHER THAN THEY ARE HAVE BEEN SET IN THE LAST SEVERAL COLD DAYS.

IN CONCLUDING ON THE COLDNESS COMPLAINTS, WHILE AN ISSUE OF WHO DOES WHAT MAY EXIST IN THE MATTER OF SUPPLYING HEAT, THERE SHOULD BE NO ISSUE ON THE POINTS, RELEVANT TO THE SITUATION AS OF THIS DATE, THAT:

- MORE HEAT IS NEEDED THROUGHOUT AT THE TIMES OF COLD DAYS.
- IMPROVED CONTROL OF HEATING WITH VENTILATION IS NEEDED.
- CONTROL OF (COLD) DRAFTS IS NEEDED IN SOME OFFICE AREAS.
- ELEVATORS NEED HEATING.
- THE 10th AND 11th FLOOR FOYERS ADJACENT TO THE ELEVATORS NEED HEATING, OR IMPROVED CONTROL OF THE EXISTING HEATING DEVICES.

CALCULATION OF REQD. VENTILATION.
SMOKING ROOM AT ONE CONGRESS ST.

1. Rubin Co proposal: 1/4 HP/ One phase. 3/8 inch water static (duct) drop. for 800 cfm.

2. 800 cfm from ?

3. EPA ORDER: "at least 60 cfm/person. of FRESH air." Order does not say all vent. air must be fresh. N.B. CAN NOT RETROFIT at this point. Use equivalent amount of interior air.

4. Rubin says "20 % intake air in supply air to floor(s)." Then, use (60 x 5) 300 cfm/person, floor air (supply) for ventilation.

5. Assume 10 active smokers at any one time. We need 3000 cfm of supply air from the general ventilation.

6. Velocity pressure (VP) is ~ 3000 = 4005 x 0.8 (Ce) (VP) E1/2. (3000/3200)E1/2 ~VP. O.9 E1/2 ~ 0.8 inches of water for air flow. TOTAL pressure ~0.8 + 3/8 inches ~ 1.2 inches water.

7. A 1 HP fan at 60 % mechanical efficiency (a good number) gives about 3700 cfm @ 1 inch total pressure drop. We need 3000 cfm.

   Use (3000/3700) -- 3/4 H.P., with the duct set up as proposed.

THIS IS NOT A DESIGN SPEC. RUBIN CO IS RESP. FOR DESIGN.

Norm Beddows.
1/3/91. 1/3/91.

REPORT OF THE MEETING OF 12/21/90.

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION I
J.F. KENNEDY FEDERAL BUILDING, BOSTON, MASSACHUSETTS 02203-2211

MEMORANDUM

DATE: December 24, 1990

SUBJ: Meeting of 12/21 re: Indoor Air Quality. Planned Additional Work.

FROM: N.A. Beddows

TO: Distribution

1. The Meeting

The above captioned meeting was well attended (47), given its proximity to the year end. This meeting was scheduled for the earliest date following on from the availability of the formaldehyde data (which were only made available on the 19th December). It had been realized that the timing would not satisfy everyone's need, but it was also realized that it was important to provide data and opportunities for questions at the earliest time; if a repeat presentation was needed, this would be done. At this meeting, a summary report was distributed; the key findings contained in the report were discussed.

2. Perceived Needs.

An outcome of the discussions which followed the brief technical presentations was the perceived need to:

(a) conduct a survey using a format which could specifically identify potential problems (and locations) in such a way that response bias could be detected, and identities could be protected from disclosure.

(b) perform a qualitative assessment of particulate in air in the vicinity of HVAC (supply) dusts, with special regard to siliceous material.
NOTE: a 0.8 micron, MCE filter/polarized light microscopy method is recommended for this I.H purpose.

(c) perform a total VOC quantitative test re: the 10th and 11th floors.

(d) hold another open, informative meeting in the near future.

3. Planned Actions to Address These Two Points Are As Follows:

(a) the writer will ask the Lexington Laboratory to perform tests re: TVOC, and particulate. Such testing should be completed if possible by late January 1991;

(b) the writer will convene a meeting in early January to arrange for the survey to be established and implemented.

SUPPLEMENTARY REPORT OF 1/27/91.

ADDENDUM TO THE REPORT OF 12/21/90.

SUPPLEMENTARY REPORT

INDOOR AIR and WORK PLACE ENVIRONMENT QUALITIES in EPA OCCUPIED SPACE.

ONE CONGRESS STREET, BOSTON, MA.

N.A. Beddows, CIH, CSP

January 27, 1991

Addendum to

" A Summary Report Of A Preliminary Evaluation Of The indoor Air and Work Environment Qualities of EPA Region 1 Occupied Space - One Congress Street, Boston, MA. December 21, 1990."

Acknowledgments

Dr. Tom Spittler and Mr. Peter Kahn made the carbon dioxide, carbon monoxide gas and volatile organic compounds analyses by infra-red and portable GC-PID. Dr. Mary Beth Smuts arranged for the initial formaldehyde measurements to be made by the state of Massachusetts.

Mr. Howard Davis provided analyses of supplied dusts. Mr. Robert Wade gave me the lighting survey data. Mr. Julius Jimeno, Mr. Jeffrey Davidson, and Mr. David Smith provided information on materials and outgassing, and they helped me in other ways. Mrs. Barbara White helped in arranging the employee IAQ-survey, as did Dr. Alverez O'Campo.

I gratefully acknowledge the truly excellent cooperation and assistance which these colleagues have given me.

N.A.B.

Summary

Since the December 21 meeting on indoor air quality in One Congress Street, new information and data have become available. This report deals with this material. Information and data are presented on furniture materials and VOC-outgassing; dust in air; target VOCs in air; lead in drinking water; the design and operating characteristics of the HVAC system; ventilation-the supplying of fresh air-and air exchange rate in the building; luminance; relative humidity; employee (IAQ) surveying; and opportunities to improve some matters of comfort and ergonomics.

Based on the information and data we have now collected and reported to all affected EPA employees, the writer believes that:

- *The frequency of formal and referred employee complaints of health problems is low (less than 1%) in regard to the total number of employees. Also, the complaints raised do not appear to have been so severe as to involve a significant amount of reportable lost work time.*

- *Formaldehyde and volatile organic compounds, reported by the manufacturer to be present as traces in the Herman Miller furnishings, are not contaminating any EPA work place.*

- *No infiltration of the offices by carbon monoxide is occurring from the nine garage floors, immediately below the offices or any other place.*

- *Work places are very clean. Dust is very low, and no mineral fibers are present in the indoor air.*

- *The extent of forced ventilation of the two office floors is excellent, and exceeds all known relevant and applicable standards*

- *There is no problem of lead in the water from the drinking fountains*

- *Problems exist re: localized heating, drafts, direct and reflected lighting, noise, and (winter) indoor air dryness. The current problems are not classed as occupational recognizable health hazards. Correction of some of these problems could be made in simple ways involving physical rearrangements and personal practices; some others would require the work of engineers and tradesmen (corrective actions were discussed in the December 21, 1990 Report).*

- *An in-depth environmental analysis is not currently justifiable. It would be possible to extend the studies made to-date to include sophisticated methodology employing off-site gas chromatography with mass spectroscopy and other methodologies. Such methods would provide evidence of the presence of trace amounts of a plethora of volatile and semi volatile compounds in the indoor air from the furnishings and the occupants, such is the great sensitivity of modern analysis. However, the toxicologic significance of mere traces of organic compounds in indoor air is unfathomable.*

1. Introduction.

An EPA - Region I Open Meeting on the captioned subject was held on December 21, 1990 at One Congress Street, Boston, MA. At this meeting we presented analytical data on formaldehyde, carbon dioxide and carbon monoxide, and we provided an evaluation of the quality of the work environment.

47 people attended. This small a number was expected. The date was close to the year-end vacations. We knew that some people would not be able to attend this meeting. Nevertheless, it was decided to hold it as planned to keep a promise to employees to keep them fully informed on ongoing tests at the earliest opportunity - which was December 21. The meeting followed the outline included in the Notice Of Meeting, which is an appendix to the Summary Report, dated December 21, 1990.

During the discussion, several participants said that the presentation should be repeated for others sometime in January. Also, several people asked to have an Indoor Air Quality Questionnaire distributed so that employees' concerns could be made known anonymously. One participant asked about siliceous material being in the air, and expressed concern about fiberglass particles. Another person wanted information on the modular furniture materials and "outgassing" of organic compounds, the VOC levels, and the HVAC system operation and air recirculation. The concern expressed was whether or not an adequate amount of fresh, clean air was being supplied to all the office spaces.

It was agreed at the conclusion of the meeting that another one would be held soon, and any new information also would be made available. The earliest available date for holding this second meeting was determined to be January 31, 1991.

New information and technical data are now available. These deal with furniture construction materials and outgassing; dust sampling and analyses; target volatile organic compounds, and relevant standards; lead in water from drinking fountains; the design, operation and capacity of the HVAC system; luminance in the work place; and a format, based on a NIOSH IAQ Questionnaire, and a proposed protocol for conducting an employee-survey.

The intent of this report, which is an addendum to the 12/21/90 Summary Report, is to:

- Report New Information and Data on:

  * Furniture construction materials and "outgassing"
  * Target volatile organic compounds in indoor air.
  * Dust suspended in indoor air.

- Disseminate Information on Lead in Drinking Water.

- Report on the HVAC System and Work Place Ventilation.
- Discuss Ventilation and Relevant Standards.
- Mention Some Current Problems, and Opportunities.
- Present an IAQ-Survey Questionnaire and Protocol.
- Summate Principle Points and Findings.

2. Furniture Construction Materials and Outgassing.

2.1. Furniture.

The furniture installed in EPA spaces One Congress Street is manufactured by Herman Miller Incorporated (HMI), Zeeland, Michigan. It is modular construction. It uses plastic covered panel tops and files and drawers, and fabric covered acoustical and non-acoustical panels. The cores of the panels and file cabinets are made of high density press-board. And pine wood is used in some panels. Chairs contain closed cell, urethane foam.

The materials used, like any other furnishing materials, are potential sources of volatile and semi-volatile organic compounds: specifically, formaldehyde, benzene, toluene and terpenes, but also a host of derivatives of these and other parent classes. What is important is not so much knowing every substance which may be evolved from these materials, but what are the respective rates of evolution, and how do these rates change over time in a ventilated office space.

2.2. Outgassing of HMI-Furniture.

Until recently, quantitative data on the outgassing of formaldehyde and other specific volatile organic compounds from new furniture set-up in a typical ventilated office layout were unavailable. This changed in early 1990, when HMI arranged for a study to be made By Air Quality Sciences of the evolution of formaldehyde and other specific organic compounds from a typical assembly of new HMI furniture in a moderately-ventilated, test chamber.

The AQS Inc. report, entitled "Indoor Air Quality Evaluation of a Work-station for Herman Miller, Inc., Report #01018-02, May 17, 1990" is available from Herman Miller Inc., c/o Mr. T. Ankney, CSP, Senior Product Safety Engineer (616) 772-3577.

In the study, a representative office set-up of 72 hour old (newly-made) furniture was used. The furniture was shipped in sealed plastic. The test chamber was ventilated (2.53 air changes per hour), and held at 77 degrees Fahrenheit and 50% relative humidity.

Monitoring was conducted for a period of six weeks. The test conditions appear to represent a credible conservative-case scenario, in the writer's judgment. All the shipping, installation and testing arrangements were witnessed, as reported by HMI, by the State of Washington.

The findings, reported by Air Quality Services, Inc., on formaldehyde and total volatile organic compounds, were expressed in terms of a warm, average size (140 square feet) office with average forced ventilation. Summarily, they showed:

1. A peak formaldehyde concentration of 15 parts per billion.

2. The (dynamically changing) first-day formaldehyde concentration was reduced by fifty percent after 40 days.

3. The peak concentration of total volatile organic compounds (TVOC) was 250 micrograms per cubic meter.

4. The first-day, TVOC (mass) concentration was reduced by fifty percent in 5 days, and the rate of change was logarithmic.

These data and the information obtained from a discussion with Mr. Tom Ankney, CPS, Senior Product Safety Engineer are consistent with the data which we now have on this facility.

NOTES.

- The low (10-18 parts per billion in December, 1990) traces of formaldehyde we had found in the work place air are believed to be from the HMI-furniture. The levels found in December are close to the urban air background (10 ppb) level. This is consistent with the expectation from the concentration and decay data given in the referenced AQS study, and the facts that (i) ventilation of the building is excellent, and (ii) the furnished office spaces were extensively aired-out for three weeks before occupancy was allowed, and ventilation has been on-going.

- In the case of volatile organic compounds in this building, assuming a first-order decay with a half-life of about 5 days applies (which is reasonable judging from the AQS-data), one would not expect now to "see" any appreciable VOCs contamination, which in fact is the case.

- As a practical matter, the quantitative data which we now have on the EPA office spaces in One Congress Street are very reassuring.

3. Dust-in-Air.

3.1. Sampling. Preparation. Examination And Findings.

3.1.1. Sampling.

Sampling of dusts from the 10th and 11th floors occupied by EPA was performed in the period 12/28/90 to 1/3/91 by the writer. These samples were examined subsequently by the writer and, separately, Mr. Howard Davis, EPA Lexington Laboratory.

Samples of air-borne dust from each floor (locations: 10th floor: NAB-JL OFFICE AREA; 11th floor, ER OFFICE) were collected on 37 mm diameter, 0.8 micron pore size, MCE filters, supported on pads in open-face cassettes. The cassettes were mounted laterally at a height of 3 feet above the floor. A (precalibrated, orifice controlled) flow rate of 11 liters per minute was used. The sampling times were selected to be 2 1/2 hours, based on prior experience in the methodology and similar environments. The sampling periods employed were exactly timed.

The air-borne dust samples are identified as follows:

DUST SAMPLE A: 1980 liters of air. Collected 12/28/90. N.Beddows'/J. Lau' Offices Aisle Space.

Note. The filter after (1980 litre) sampling was unstained. This indicates at least that the air was free of coarse particulate (visual soiling increases as the squares of the diameters of the visible-range particles).

SAMPLE B: 1903 liters of air. Collected 12/28/90. E.Riemer's office.

Note. The used filter was unstained indicating, at least, freedom from coarse particulate.

3.1.2. Preparation for Microscopy.

After sampling, the (two) filters were cut to provide l/8 sectors for examination. Each sector was cleared using acetone, and covered with a slip-cover. The prepared wedges, were (i) examined immediately by the writer, and (ii) preserved and respectively identified by "NAB markers" for subsequent independent examination By Mr. H. Davis (who was on vacation until 1/8/91).

3.2.3. Examination (Microscopy) And Findings.

3.2.3(a). Report of Findings-1/3/91.

The prepared wedges (Samples A and B) were examined on 1/3/1991 by the writer using polarized light microscopy (PLM) to identify materials and (secondarily) size the particulate. This involved looking at several hundred optical fields of each of the prepared wedges using a nominal 400X magnification with PLM.

DUST SAMPLE A (Note. The optical fields were scarcely loaded).

OBSERVED: Rough round mineral particles. Cellulose, cotton, and hair fibers.

ABSENT: Mineral fibers (e.g., asbestos, fiberglass, rockwool). Clearly crystalline mineral particles.

DUST SAMPLE B (Note. The optical fields were scarcely loaded).

OBSERVED: Round mineral particles. Cellulose and hair fibers. Cottons and synthetics. Round (about 10-15 micron diameter) particles, found in about 5 optical fields, and tentatively classed as "vegetative".

ABSENT: Mineral fibers. Clearly crystalline mineral.

3.2.3(b). Report of Findings of H. Davis-1/8/91.

An independent microscopic examination of the supplied dust sample wedges was performed on 1/8/91 by Mr. Howard Davis, EPA Lexington Laboratory (Laboratory Project No: 91072). Summarily, Howard confirmed the 1/28/91 findings. Additionally, he identified pollen (10 micron diameter round particles) in sample B, reported that one glass fiber was observed on the inspected wedge from the sample A filter, and found starch particles in the two samples.

4. Evaluation of Volatile Organic Compounds (VOCs) & Standards.

4.1. Sampling and Evaluation Of VOCs-Floors 10 & 11.

4.1.1. Sampling.

Selection of representative floor locations for sampling and sampling were done by Mr. Peter Kahn and the writer. A minimum of five air samples per floor were taken in open center and end area spaces. Also, the 10th floor smoking room (with 5 active smokers in the room) was sampled.

4.1.2. Target Compounds.

Certain common chemicals were targeted in the analysis. These were selected because either they evolve from office furnishings or are found in cleaning agents. The compounds are principally toluene, benzene, the o,m,p xylenes, halogenated aliphatic and aromatic hydrocarbons, and simple and ethoxylated alcohols. Other (GC.PID-responsive) low boilers were also sought.

4.1.3. Evaluation.

Target volatile organic compounds in the indoor air were evaluated on 1/8/91 using a portable gas chromatograph with a photoionization detector (PID at 10.2 ev). Analyses, using reference VOC blends prepared in advance, were made on site by Dr. Tom Spittler and Mr. Peter Kahn, EPA Lexington laboratory.

4.2. Findings: VOCs-Floors 10 & 11.

4.2.1. Preliminary Observations- 1/8/91.

Dr. Tom Spittler kindly provided a prompt verbal report of his initial observations: "only a few parts per billion each of toluene, benzene and a few other volatile compounds [were] present", and "the 10^{th} and 11^{th} floors are consistently clean."

4.3.2. Formal Report.

A formal report is in preparation by Dr. Tom Spittler and Mr. Peter Kahn. It is planned for completion on 2/8/1991, after which date, copies will be available from the laboratory.

The findings were reviewed extensively by the writer with Peter on 1/28/91. Summarily, the review affirmed the findings given to the writer in the verbal report of 1/8/91. Benzene, toluene, and trichloroethane were found to be present at approximately 5 parts per billion, and this correspond to the background outdoor levels which were measured on the same day. Thus, only trace concentrations were found in the air on either floor. The combined total of the target compounds found was much less than 115 parts per billion, which is the concentration which is used by the writer as indoor air quality (TVOC) guidance (please see section 3.4.3).

4.4. Standards For VOCs In Indoor Air.

4.4.1. The Washington State 1989 TVOC-Standard.

Washington State has established a compliance standard re: a total of known volatile organic compounds (TVOCs) in indoor air which is relevant and applicable to our study. The daily average limit of exposure is 500 micrograms per cubic meter.

4.4.2. Relevance of the Washington State 1989 TVOC Standard.

The (mass concentration) limit of 500 micrograms per cubic meter is only directly convertible to a "total parts per billion" term, when the actual mixture of the VOCs present is known. This is not usually the case, especially when field evaluations are made using a portable GC instrument, which is generally the easiest way to make an evaluation.

Generally, one does not need to know the complete array of (the traces of) the common garden variety air contaminants which are usually present indoors. Such information may not be especially helpful because very low dose-response toxicity data on room temperature-volatile chemicals in indoor air appear to be either scant, speculative or highly imprecise. This leads one to look for a general approach to assessing data on indoor air.

4.4.3. A Volumetric Standard for Common VOCs in Office Air.

It is possible to arbitrarily and sensibly set a corresponding "total parts per billion" limit for a mixture of suspected common garden variety organic contaminants which are believed only to have additive toxicity and similar (only moderate acute irritating) properties -- properties which manufactures of furnishings and office cleaning compounds are careful to consider and evaluate. This entails using an arbitrary reference. A known compound or blend of compounds (whose molecular weights are also known) is used. The reference compound or blend must have appropriate volatility and toxicity characteristics.

The o,m,p zylenes (C_8H_{10}. M.W. = 106), being slow to evaporate at room temperature and moderately irritating (eye), in the writer's judgment, can serve as the reference chemical to derive an assumed-equivalence, volumetric standard for the common garden variety volatile organic compounds likely to be found (but unlikely to be fully characterized) in an on-site, indoor air quality investigation.

Using this approach, the (xylene assumed equivalence) limit is 115 parts per billion, for the common garden variety VOCs in indoor air, viz: [500 x 24.45 (the mol.volume)/106 = 115 ppb]. This value is about an eighth of the volumetric concentration (1 part per million) of a known blend of 22 common organic compounds shown to be minimally acutely irritating, in tests made in 1985 by L. Molhave et al., (referenced in the 12/21/90 report). It could be used as a go-no go gage for use in deciding to further consider doing additional (GC-MS) analysis.

Until a standard, covering typical indoor air contaminants, which is either mandatory or well based on toxicological data comes forth, 115 ppb will be regarded by the writer as a guide to an acceptable daily exposure to common garden variety indoor VOCs (excluding formaldehyde, for which a standard exists).

5. Other Tests and Information.

5.1. Luminance: Levels and Standard.

5.1.1. Recent Spot Measurements.

The overhead illumination of certain offices, as measured at open desk top areas, is evidently sub-standard in some offices, especially in late afternoon winter periods. Reportedly, luminance at desk top levels, unobscured but without the under-cabinet lighting being on, is less than 15 foot-candles in some cases, and use of the under-cabinet lighting does not remedy the problem.

NOTES:

- The illumination from a particular candle power source, at some location at a specific distance, and at a specific angle of incidence varies inversely with the distance squared and directly as the cosine of the angle. With the current lighting fixture grid, in the worst case, the incident angle, relative to the middle of the office(s) served, is about 45 degrees (cosine, 0.707). In this case, the illumination could not be increased by more than about a third (0.3) by repositioning the fixture so as to be directly overhead. This fact needs to be kept in mind when one evaluates the alternatives of repositioning fixtures or adding new overhead lighting in problem offices were the desk level illumination is less than 40 foot candles, and 50 foot candle illumination is needed. In such a case, an additional fixture would be required for a office.

- Adding more overhead office lighting could cause a power overload. This happens now when lamps and heaters are used in some offices. Any addition of office lighting may have to be offset by removing some of the lighting fixtures in the aisles and elsewhere.

5.2. Lighting Survey

A comprehensive evaluation of office lighting is now being made by Mr. Robert Wade. His findings will be reported separately, and could be used as a basis for future corrective action.

5.3. Illumination Standard.

The prevailing EPA Region 1's standard for lighting for desk-tops is 50 foot candles. This level of lighting was incorporated by the writer in a set of (1989) preliminary specifications (for a new EPA facility) which were to be provided by EPA Region 1 to GSA.

50 foot candles at the task is a higher standard than the (30 foot candles) requirement for library reading rooms that one sees in older literature. However, the anticipated prolonged reading and writing duties of many of the staff persuaded the writer to propose the 50 foot candle, task illumination limit; the perceived need has not changed.

5.4. Lead in Drinking Water. Findings and Standards.

5.4.1. Sampling.

Water (from fountains and sinks on the 10^{th} and 11^{th} floors) was sampled for lead in December, 1989 by Mr. Albert Pratt, Lexington laboratory. Four drinking fountains and some sinks were (first-flush) sampled.

5.4.2. Findings.

Each sampled drinking fountain provided water which was determined to contain lead only at or below a concentration of 6 micrograms per liter - the level which is the limit of sensitivity of the test. One (first-flush) sample of sink water was reported to have a lead concentration of 28.4 microgram/litre. However, a duplicate sample (instantaneously taken) of this supply was reported to contain lead only at or below a concentration of 6 microgram/liter (ug/L). In this case, the first lead level is an undetermined anomaly.

5.4.3. Lead-in-Drinking-Water Standard.

The current standard for lead in drinking water is 50 ug/L. A proposed (for 1991) national standard is 15 ug/L ("first-flush" sampling).

5.4.4. Status of the Water Supply And Assurance.

There is no problem with Lead in the drinking water from fountains on the floors. For continued assurance, annual sampling and testing of all the fountains is recommended.

6. The HVAC-System. Capacity And Standards.

6.1. The System.

The HVAC system in the building is a modern design, variable air volume (VAV) system. It utilizes individual VAV-units, each VAv unit has individual ducts for air intake, air recirculation, and air supply (this is unlike the case in the former EPA premises at Government Center which employed the ceiling plenum as the low-velocity, high volume exhaust component of the HVAC).

The variable air volume (VAV) system arrangement is shown and described in the report entitled " Some Comments On The Design, Operation, And Capacity Of The HVAC System", issued by the writer on 1/14/91, and reproduced in the Appendix.

As a summary, the system comprises a total of 168 sub-units (VAVs) each of which employs an outside air-to-supply air ratio of a minimum of 20%, and this level of fresh air intake value may increase in the spring and fall. The filtration employed is conventional (not HEPA). The filters are required to be changed twice a year. In the event, however, that they are not changed at this rate, filtration only improves, however, the cost of operation of the HVAC fan drives increases; ultimately, flow rate is reduced significantly.

6.2. Capacity.

As stated previously, the VAV system employs 168 units, some of which have different flow rates, ranging from a minimum of 800 cfm (HVAC drawing designation: A-Boxes)

to a maximum of 3240 cfm (designation; B-Boxes). It is not practical to make a precise estimate of the rate of supply of outside air per person at this time because "as-built" drawings are not available to either EPA or the building management, and checking the setting of each VAV unit can not be done now. However, it is possible to conservatively estimate the outside air supply rate per person, by spot checking individual VAV units for intake and output flow rates and by using a mean value for the average (VAV box) unit supply capacity. This has been done by the writer.

The level of outside air supply per person is estimated by the writer to be approximately 25 cfm per person; and the air change rate is estimated to be approximately four per hour. This level of ventilation exceeds all known relevant standards for non-smoking offices. Fresh air ventilation is judged by the writer to be excellent on both floors.

For a more detailed explanation, please see the referenced report in the Appendix.

6.3. Ventilation (Fresh Air) Standard.

The ASHREA Standard of 1989 specifies 15 cfm to 20 cfm for the types of occupancy which are relevant. For more detailed information, please see the referenced report in the Appendix.

7. IAQ Questionnaire: Survey Form and Protocol.

7.1. Form.

NIOSH and EPA have jointly established a format for assessing indoor air quality through an employee-survey. The format has been provided in a draft of a proposed document which has not yet been released as public guidance.

The elements of the format are completely incorporated in the form reproduced in the Appendix. This form has been tentatively approved by the Union President and the Medical Director, PHS - Division of Federal Occupational Health, Boston, MA) for use in conducting an IAQ Survey at EPA Region 1, One Congress Street, subject to the safeguarding of any required confidentiality.

7.2. Protocol

At the December 21st EPA open IAQ-meeting, several participants made the point that a confidential survey of occupants ought to be taken. This point was accepted by the management. To assure confidentially would be provided and maintained, the following key steps or an equivalent procedure could be followed:

1. The manager of safety distributes an approved survey to either all or some appropriate sample number (as determined by the management) of the EPA employees, One Congress Street.

2. Employees send their responses in a sealed envelope to the Medical Director, Public Health Service - Division of Occupational Employee Health (Government Center, JFK Federal Building, E120).

3. The Medical Director assesses the information, assures confidentiality, and provides a written summary report to the EPA HQ Safety Director, with copies to the Union President, the Safety Manager, and other EPA personnel who are authorized in any way to get a copy from the medical Director.

4. The Safety Manager, from the information provided, will identify any needed corrective action, and report the need to the management.

8. Other Relevant Points.

8.1. Recent Articles-aspects of chemical sensitivity.

Several short articles appeared in December in the Boston Globe and the Ma Safety Council magazine (please see the appendix).

8.2. Relative Humidity. Comfort Limits. Levels. Controls.

8.2.1. Relative humidity (RH%).

This is a term which expresses as a percentage the water vapor in the air relative to the maximum amount of water vapor that the air can hold at the particular temperature and pressure. Relative humidity does not indicate in an absolute sense how much vapor is present.

8.2.2. Comfort Limits.

Most (97%) occupants doing indoor sedentary work will feel comfortable in the winter months provided the relative humidity does not go below 30 percent when the minimum indoor (dry bulb) temperature is 70-72 degrees Fahrenheit, and the air movement (draft) is not more than about 15-20 linear feet per minute with any prolonged head, neck, shoulder or leg (skin) exposure.

When air movement is at or greater than 20-25 linear feet per minute at the skin, a definite draft will be noticed.

One can expect to receive complaints from occupants of dry skin and irritation of the mucous lining (eye, nose) when the winter time indoor relative humidity is less than 10 - 15%, despite the fact that the temperature is adequate for comfort.

8.2.3. RH% Levels. December/January.

In the period of mid-December to mid-January, relative humidity values in the range of 20% to 30% were measured repeatedly by the writer using an accurate sling psychrometer.

8.2.4. Controls

8.2.4(a). Engineered Control.

The building is not equipped to control winter-time relative humidity. It is not practical to retrofit such control to the HVAC in this building.

8.2.4(b). Use of (Safety) Approved Humidifiers.

The use of (U.L. approved) humidifiers in offices during regular work hours is not prohibited. All relevant electrical and fire safety controls and hygienic practices must be employed when they are used. They can not be used where they will trip the electrical circuit breaker. The use of a humidifier in an open office space may not be effective.

8.2.4(c). Personal Hygiene.

Certain over-the-counter skin emollients, nasal sprays and eye drops appear to be beneficial in offsetting the effects of dryness experienced in offices during winter months. If such products are used, one should take care to ensure that they do not aggravate the condition being treated; this can occur in some cases.

8.3. Engineered Control of Office Noise.

It is feasible to economically acoustically treat some problem offices, but other areas may not amenable to treatment. The engineered control of office noise is a specialist's job. Further discussion of the subject is beyond the scope of this report. However, typical literature which illustrates what might be useful to control noise and speech transmission in some problem offices is given in the Appendix.

9. Key Points in Summation.

Based on the information we have garnered to date, the following key points are offered:

o <u>The frequency and severity of employee complaints are relatively low.</u> Formal (two intotal) and referred (about 10) complaints concerning health or safety problems equate to less than one percent of the total number of employees on the two floors. However, the current level of complaints about cold areas, drafts, and air dryness is high; and the cold and draft complaints are evidently mostly valid.

- Formaldehyde and volatile organic compounds are not significantly contaminating the work place. These compounds are present at trace levels in the Herman Miller furnishings, but they have only been found at low (parts per billion) llevels in EPA work places.

- No infiltration of the offices by carbon monoxide is occurring. Carbon monoxide levels are at "background" concentrations; no evidence exists to even suggest that infiltration occurs from the (nine) garage floors immediately below the offices.

- Work places are clean. The dust is very low, and no mineral fibers are present in the indoor air.

- The extent of forced ventilation is excellent. Outside air is suplied to the two office floors in amounts which exceed the ventilation requirements in all known relevant and applicable standards. Ventilation level is excellent but temperature balance is poor at this time.

- There is no problem of lead in the drinking water from the drinking fountains.

- Problems of heating, lighting, noise and air dryness exist. These problems relate locally to either heating uniformity, drafts, direct and reflected lighting or noise. Also, (winter) indoor air dryness is a problem. These matters are not currently classed as recognizable health hazards, but they may very well be strong "dissatisfies." Correction of some of these problems can be made in simple ways involving physical rearrangements and personal practices; some others will require the work of engineers and tradesmen. Corrective actions were discussed in the December 21,1990 Report.

NOTE.

  - The problems of lighting, noise and temperature control are being addressed by the services branch. The problem of periodic dry air can not be resolved in an engineered way. However, some of the practices mentioned earlier on this point should be beneficial to many of those people who are only minimally affected by the winter-time indoor air dryness.

- Taking an Indoor Air Quality (IAQ) survey is planned. This action is planned in response to requests from a small number of employers and the recommendations of some EPA supervisors and the Medical Director of the Public Health Service, Division of Federal Employees Occupational Health. Such a survey is intended to elicit information in confidence any on any actual or perceived health or comfort problem.

The writer has offered a technical format, based on a formal joint NIOSH-EPA method, and a protocol to implement the plan, and has made arrangements for any assessment to be made in full confidence. All completed survey forms would be sent directly to the Medical Director.

The survey may provide information indicating that one or more occupational hazards exist, or that changes could be made to improve ergonomic matters. If this turns out to be the case, the recommendations provided by the Medical Director will be responded to properly.

Despite the above matters, the planned survey is neither endorsed nor opposed by the writer. No occupational health problems are known which would cause one on these grounds alone to take one side or the other. Of course, the apparent imbalance in the heating and lighting systems and other considerations may suggest to the management the need for the survey.

- Forced ventilation of the smoking room is evidently needed. This matter was fully reported in the report of 12/21/90. At this time, a recommendation to install a 3/4 HP axial fan (for 60 cfm/person), with total exhausting to the outside, has been concurred with by GSA, and a work order has been processed.

- An in-depth environmental analysis is not currently justifiable. It would be possible to extend the studies made to-date to include sophisticated methodology employing off-site gas chromatography with mass spectroscopy and other methodologies. Such methods would provide evidence of the presence of trace amounts of a plethora of volatile and semi volatile compounds in the indoor air from the furnishings and occupants, such is the great sensitivity of modern analysis.

The toxicologic consequence of indoor air exposure to a few parts per billion of a single chemical or a blend of chemicals of the types and classes which are ubiquitously present seems to be unfathomable, even when extraordinary efforts are made. Stated simply, there are few if any relevant low dose-response data. And, the data which exist are speculative and may have many orders of magnitude of uncertainty. Also, associated costs would be major. In short, no health risk or possible likely health or likely benefit of any kind is known currently to the writer to justify expending tens of thousands of dollars which surely would be needed for such a pursuit.

N.A.B. 1/27/91.

Post Script.

On 2/19/91, the building owner installed a roof-mounted 3/4 HP fan extractor (with an 18 inch square duct to the outside of approximately 20 ft/straight section; and 1.2 in. water total pressure drop). The regular smokers report the improvement is very good. They were all pleased. There is no excessive noise, draft, or negative pressure in the room. The door (sans grid) opens easily against the exhaust. A draft is discernable at the center of the room. A 3/4 HP unit seems to be just about right, as calculated, for this 30X20X10 room.

Appendix

MASSACHUSETTS SAFETY COUNCIL, INC.
111 Beach Street, 2nd Floor, Boston, Massachusetts 02111-2511
(617) 542-8057

Occupational Asthma Alert / People who develop asthma as adults and have more symptoms during the work week than on weekends may be suffering from occupational asthma.

The disease is often caused by exposure to irritants in the workplace. These irritants may be biological agents such as grain, flour, animal dander and antibiotics like penicillin, or chemical agents including formaldehyde, naphthalene and toluene di-isocyanate (TDI).

Asthma symptoms include wheezing, tightness in the chest and difficulty breathing. When the disease is diagnosed early and patients avoid the irritating substance, they are able to recover complete lung function. Longer exposure may result in more severe health problems such as pneumonia.

Employers are advised to be aware of asthma symptoms among their workers and improve working conditions when necessary.

Better Light for VDT's / Indirect office lighting can significantly reduce eye problems and loss in worker productivity caused by glare from video display terminals, according to a recent study conducted by Cornell University.

The study, begun in 1988 at a Xerox Corp site in New York, studied the effects two different types of lighting had on computer-screen glare. Half the offices were equipped with conventional overhead fluorescent lighting or downlighting. The other half had indirect fluorescent lighting that directs light toward the ceiling, called uplighting.

Nearly a fourth of the computer users in offices with downlighting said they lost 15 minutes or more each day because of difficulty focusing on the screen and more than 10 percent complained of watering or itchy eyes, compared to only 1 percent of workers in offices with indirect lighting. In addition, loss of productive work time caused by tiredness or lethargy was four times greater in the group with conventional computer area down lighting.

A follow-up study 12 months later found 71 percent of the employees preferred the indirect lighting system. Furthermore, 74 percent of those working under convention downlighting said they preferred indirect lighting.

Occupational Health

$8 Million Ergonomics Program Launched At Pacific Bell

OAKLAND, Calif.—(By a BNA Staff Correspondent)—Pacific Bell in California aims to cut down stress and strain among employees who work with video display terminals (VDTs) in a two-year ergonomics program that will retrofit existing offices and furnish employee training.

The company has been developing its ergonomics program since 1985, according to Jill Foley, Pacific Bell's manager for public affairs. All of the 55,000 Pacific Bell employees who use VDTs are to receive ergonomic training by the end of 1992, she said.

Foley said that one office in Concord, Calif., which employs 101 operators had already been retrofitted prior to the announcement that the firm's program was being stepped-up. Operators in the retrofitted office can adjust the height of their chairs and desks so they can sit or stand while working and use keyboards in a straight-wrist position. Walls in the working area and partitions at workstations have been coated with fabric to cut down on noise levels.

According to Foley, a survey is now under way to determine which departments should be considered first for retrofitting and training. The results should be in and the retrofitting and training started by the first quarter of 1991, she added.

The Pacific Bell ergonomic program is being eyed with interest in San Francisco, where a proposed ordinance that would regulate VDT use in firms employing more than 15 VDT workers is before the Board of Supervisors.

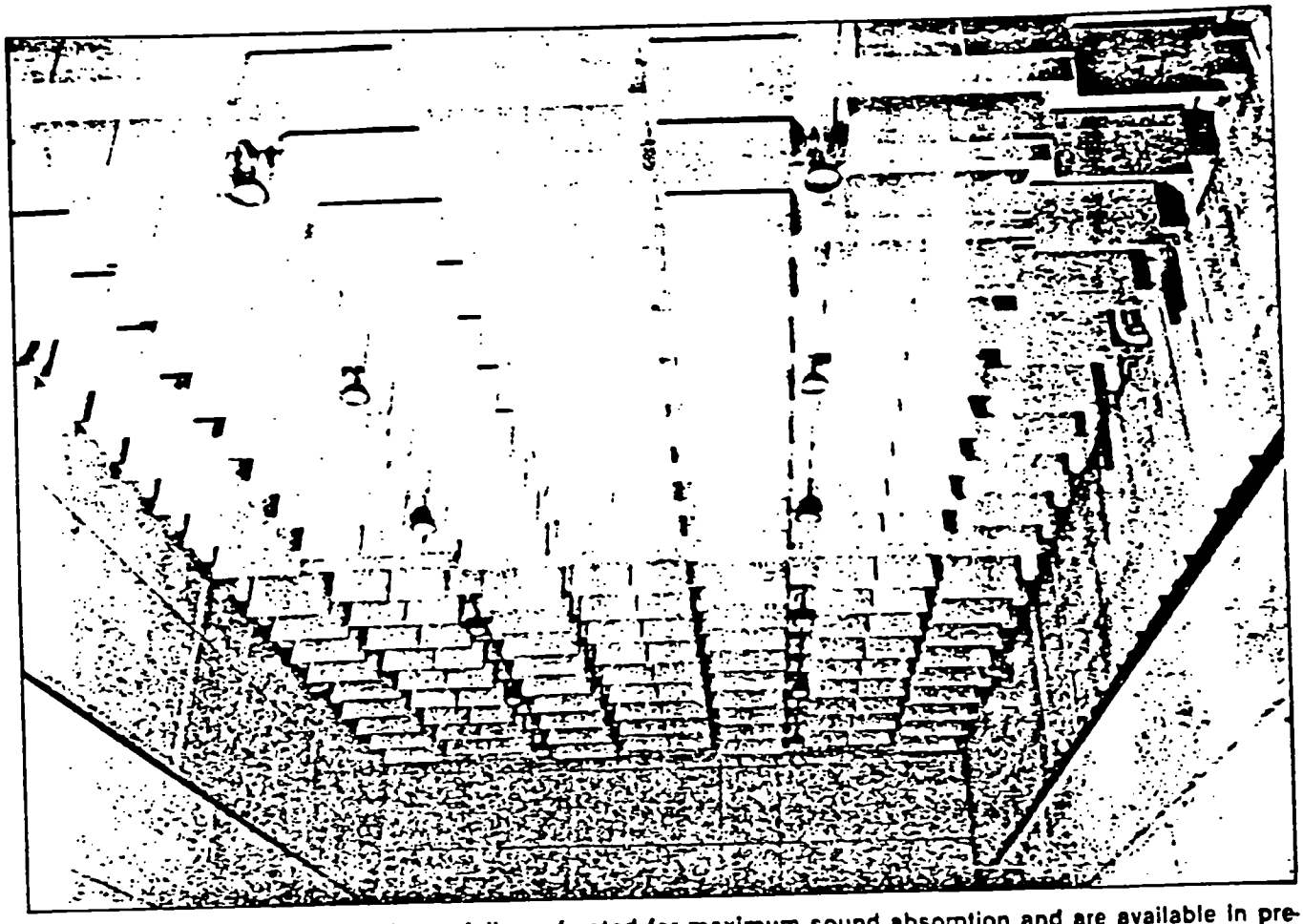
The San Francisco Chamber of Commerce is drafting guidelines for its own set of voluntary VDT-use standards as a proposed alternative to the ordinance under consideration. The chamber's voluntary guidelines are expected to be ready by the beginning of 1991. "We think that the Pacific Bell program is one of the models," Carol Piasente, the chamber's communications director, said.

However, Joan Moore, secretary for the Communications Workers of America Local 3310, which represents 3,300 Pacific Bell employees, questioned the phone company's commitment to extending its ergonomics program beyond what Moore termed a "showpiece" office in Concord.

"They have 300 offices in California and that's only one," according to Moore, who also serves as safety chairwoman for the union's Northern California and Nevada Council.

HERE'S HOW

Modular Sound-Absorptive Panels Foil Powerhouse Noise Problem



Ceiling-hung Noise-Foil III panels are fully perforated for maximum sound absorption and are available in pre-finished materials—steel and aluminum. Acoustical performance of these panels (as well as the others in the Noise-Foil family) were confirmed by testing in facilities of the IAC Aero-Acoustic Laboratory.

Amid the scenic Blue Ridge Mountains in northeast Georgia, not far from the Tennessee state line, Carters Lake glistens in the sunlight. The sparkling waterbody with a wooded shoreline contributing to its natural beauty is man-made to serve as a flood control and power-generation resource by a dam on the Coosawattee River.

Situated at the foot of the 445-ft (136m) high Carters Lake dam is a 390-ft (119m) long by 115-ft (35m) wide hydroelectric powerhouse. To produce electricity, runoff water, which the lake collects from a 375-square mile surrounding area, flows through four 18-ft (5.5m) (inside diameter) penstocks to the powerhouse, rotates pump turbines activating 125,000-kw-capacity hydrogenerators, and discharges into a reregulation reservoir below the powerhouse. Water is pumped back into the main lake when demand for power is low, usually during the night and on weekends.

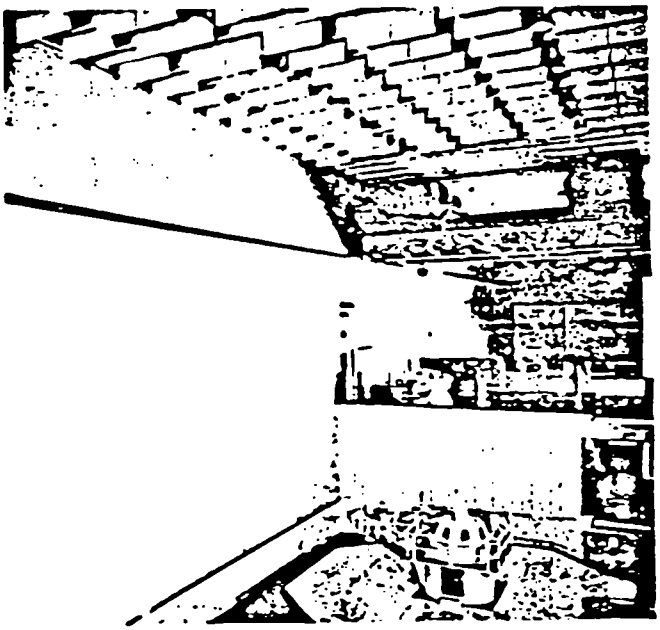
According to the US Army Corps of Engineers, Mobile District, South Atlantic Division, managing the Carters Lake project and operating the powerhouse, power releases and pump-back of the water cause levels of the reregulation pool to vary as much as 10 feet (3m) within a 6-hour period, to rise up to 22 feet (6.7m) from Monday to Friday, and to drop as much as 22 feet (6.7m) over a weekend. Pump-back results in weekend fluctuations in Carters Lake of up to 4 feet (1.2m). The powerhouse engineering staff credits reuse of the water with substantially increasing capacity of the facility

—Environmental Management Includes Noise Control—

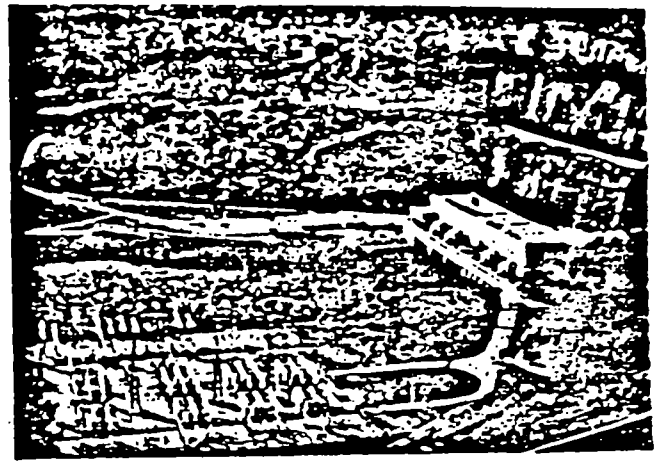
Administration of this hydroelectric resource includes maintenance and improvement of the powerhouse environment outside and inside. Noise control has been a major accomplishment in the interior. With pumps and generators running, noise levels have been as high as 97 dBA, a condition amplified by reverberations resounding from the hard-surface, sound-reflective concrete ceiling and walls of the powerhouse.

In a project aimed at reducing these noise levels below OSHA limits, the Corps of Engineers specified prefabricated sound-absorptive Noise-Foil panels which Industrial Acoustics Company designs and manufactures. Installation called for panels to be suspended vertically from the ceiling and flush mounted on the walls.

So, from the ceiling were hung 550 cable-supported, pre-finished, white, aluminum 3-inch-thick (76mm) modules (Noise-Foil III) 48-in (1219mm) wide by 78-in (1981mm) long containing verminproof and mildew-resistant fiberglass fill for a 14,300 sq. ft. (1328) sq.m.) total of acoustical treatment. Since all six of its sides are designed for sound-absorption, each panel maximizes the beneficial effects of sound-wave diffraction. Overall surface exposure and panel acoustical interaction were factors influencing choice of this Noise-Foil System to improve environmental conditions in the powerhouse.



Noise-Foil II (walls) and III (ceiling-suspended) are two of four sound-absorptive, modular designs with varying construction characteristics offering wide application options. All panels provide a practical and effective means of reducing noise levels associated with reflected sound in industrial plants. Installation of the panels in the Carters Lake powerhouse was coordinated by the IAC area representative, H. Clay Moore & Assoc. of Atlanta.



Carters Lake powerhouse as seen from the top of the dam site.

Complementing the ceiling installation are 1,250 wall-mounted Noise-Foil II pre-finished, white, aluminum 2-inch-thick (51mm) panels. Each is 18-in (457mm) wide and 120-in (3048mm) long with the fiberglass fill bagged in sealed, dustproof plastic to prevent deterioration from humidity and dirt accumulation. Bolted to interior surfaces, the panels are tightly integrated with pre-painted joiners and connectors for an altogether secure echo-preventing system.

—Acoustical Systems Benefits Are Multiple—

In combination, the ceiling panels and wall liners cut noise levels through sound absorption. Each Noise-Foil System is characterized by a Noise Reduction Coefficient (NRC) of 0.90, meaning that 90% of the sound energy incident to surface of a panel is absorbed. High performance in low frequencies (63 Hz and 125 Hz—typical of the rumble of powerhouse pumps and generators) tones down the boom and echo in these troublesome ranges.

Provided in response to an analysis of the best way to neutralize the noisy conditions of this hydroelectric facility, the Noise-Foil Systems were installed without interfering with powerhouse operations. Acoustical performance has been checked at various locations throughout the plant showing that noise levels at all points do not exceed the OSHA exposure limit of 85 dBA during the normal eight-hour working day. The modular acoustical treatment for this powerhouse is considered exemplary of the type of sound-absorption that can be introduced into hydroelectric and other categories of industrial plants.

Carters Lake powerhouse is capable of producing an average of 500,000,000 kilowatts annually (roughly enough electricity for 50,000 customers). Wattage generated is delivered at the switchyard to the Georgia Power Company under a contract supervised by the Southeast Power Administration. No one, then, living and working in northeast Georgia who expects an immediate response from flicking on a light, plugging in an appliance, turning on a machine, or making any of the innumerable daily demands for electric current, need be concerned that service will not be instantaneous—thanks to the environmentally enhanced Carters Lake powerhouse.

INDUSTRIAL ACOUSTICS COMPANY

1160 COMMERCE AVENUE BRONX, NEW YORK 10462 PHONE: 212-931-8000 TELEX: 12-5880 FAX: 212-863-1138

Garden Grove, CA 92643 10971 Garden Grove Boulevard Phone: 714-636-5440 Fax: 714-636-5443

Staines, Middlesex, U.K. Central Trading Estate Phone (0784) 45651 Telex: 25518 Fax: (0784) 463303

4055 Niederkruchten, W. Germany Phone: (2163) 8431/2 Telex 852261 Fax: (2163) 80618

TECHNICAL REPRESENTATION IN PRINCIPAL CITIES THROUGHOUT THE WORLD

iac THE STANDARD OF SILENCE

Printed in U.S.A.

Study: Environmental illness a mental disorder

CHICAGO (AP) – People who think the modern, chemical-saturated environment is making them sick may simply be suffering mental problems, a University of Iowa research group says. Critics called their study naive and sloppy.

Patients diagnosed with the syndrome known as environmental illness often get sick after exposure to everyday items like processed foods, newsprint, gasoline and clothing.

Belief in the condition, also called multiple-chemical sensitivity, varies in the medical community, with some doctors doubting its existence altogether.

"It's my belief that people diagnosed as having environmental illnesses in most cases do have something wrong: a garden variety emotional disorder," said Dr. Donald W. Black, who headed a study at the university's medical school published today in the Journal of the American Medicine Association.

Beginning in June 1988, Black's research team studied 21 people diagnosed as suffering from environmental illnesses. Fifteen, or 65 percent, showed symptoms of past or present mental disorders like depression, anxiety or obsessive compusive behavior, the study said.

In a 46-member control group of healthy people, 13, or 28 percent, showed symptoms of mental disorders, the study said.

The research was naively conceived and poorly set up, said Dr. Leo Galland, a New York internist who treats people diagnosed with environmental illness.

Comparing the mental conditions of environmental illness patients against healthy people, rather than the mental states of people suffering medically accepted chronic ailments, was a critical flaw, Galland said.

"Being sick tends to make people depressed," he said. "I don't think there's ever been a study done comparing healthy community members with a group of patients who suffer from a chronic illness that hasn't found more psychopathology among the patient group."

Comparing the mental conditions of environmental illness subjects with those of people with asthma, for example, might have proved his claim, he said.

A group of medical practitioners called clinical ecologists believe that common chemicals in the air and physical environment can upset the body's immune system, leading to nausea, respiratory problems, headaches and other ailments, the study said.

Some patients have reported hypersensitivity to rugs, paneling, deodorant, bedding and other everyday substances. Some sufferers have sought out "toxic free environments" by giving up their urban jobs and moving to the desert or mountains.

A lack of an acceptable definition for environmental illness, as well as a lack of an established test for the disease, has led much of the medical community to dismiss the concept, the researchers wrote.

Another critic said even if the Iowa team's conclusions were valid, toxins in the environment could have contributed to the mental disorders.

"I don't think any psychiatrist can tell me what causes mental illnesses like depression and neurosis," said Dr. Max Costa, professor of environmental medicine and pharmacology at New York University Medical School.

Black's research team also criticized the use of non-proven treatments on people diagnosed with environmental illness. Those treatments include special diets, wearing filter masks and using douches or enemas of spring water, coffee or yogurt.

Baton Globe 12/20/90.

NOTICE OF UPDATE MEETING OF 1/31/91.

EPA REGION 1 UPDATE OPEN MEETING

Evaluation Of The Indoor Air and Work Environment Qualities Of EPA Spaces At One Congress Street

***** INVITED SPEAKERS *****

Norm Beddows, Health and Safety Manager, EPA Region 1.
Jeff Davidson, EPA HQ-OHSS, Washington.
Pat Meaney, ARA, EPA Region 1.
Dr. Ocampo, Medical Director, Div. Occ. Fed. Occ. Health, PHS.
Tom Spittler, Laboratory Director, EPA-Lexington Laboratory.
Barbara White, National President, AFGE-Union.

Date---------- JANUARY 31
Time---------- NOON to 1:30
Place----EPA 11fl. Conference Room.
One Congress Street.

Information will be presented on indoor air quality, and work place environmental quality. Included will be information and data (on carbon dioxide, carbon monoxide, and formaldehyde concentrations) which were presented at the December 21, 1990 open meeting on the above captioned subject. Also, supplementary and new information will be presented in response to our intention to keep employees fully appaised of work place quality factors, and the questions and points raised by the participants in the December meeting. This information covers specific furniture construction materials and gaseous evolutions; measured lead in (fountain) drinking water, stardards, and sampling plan; ventilation system type, and outside air supply and standards; dust characterization; quantitative analyses for volatile organic compounds; a plan and format to survey EPA Region 1's employees, and other relevant points and opportunities.

REPORT OF UPDATE MEETING OF 1/31/91.

Indoor Air & Work Environmental Qualities
One Congress Street, Boston, MA

Report of Update Meeting, January 31, 1991.

January 8, 1991.

1. Pre-meeting Notices.

The schedule for the above captioned meeting was extensively advertised (two weeks) in advance. Notices were sent to EPA personnel and supervisors in the building, and were posted on the 10th and the 11th floors, at the respective reception desks.

2. Panel and Attendance.

The panel comprised J. Davidson, P. Meaney, B. White and the writer. Dr. O'Campo (US.PHS) and T. Spittler were invited, but they were unable to attend.

Sixteen people participated. These included five human relations specialists; three facilities specialists; people who had raised concerns on earlier occasions and other people.

3. Documentary Material Presented.

The Supplementary Report, dated 1/29/91, on the captioned topic was distributed. A summary presentation of the report was made using overhead visuals (copy attached). All of the information available to date was provided at this meeting. Copies (100) of the Supplementary Report were placed at the reception desks on the two floors, immediately following the meeting.

4. Points of Discussion.

The principle points which were made dealt with the following matters (responses are reported at section 5):

4.1. Reported Lead in drinking Water.

(A). One participant said that the number used by the laboratory as a reference level, i.e., "less than 6 micrograms per liter of lead", should be a lower number, and the person said this was a "good laboratory practice" requirement; "5 g/l" was mentioned as a possible number but lower values of concentration were also mentioned at the same time.

(B). Another participant raised the point that the (sink) water which reportedly had 24.8 ug/L was a concern, and objected to the sampler's verbal "unexplained anomaly" description which was included in the writer's Supplementary Report of 1/29/91. This participant also wanted to know - -

(C). Was lead-bearing solder used in the fountains/water supply.

4.2. Formaldehyde in Air in Earlier Periods.

Another person said that there must have been a formaldehyde problem at the start, considering that the HMI furniture study data indicated a 40 day half-life, and the writer's data showed 10-14 ppb, in December.

4.3. Carpet Pile "balling".

The same person said that when chairs are moved over the carpet, fibers "ball up", and he was concerned about the respiratory hazard from the fibers being released.

4.4. Interim Construction Hazards.

Another commentator said that construction (on the 11th floor) of offices, using plaster-board and water and solvent paints, was in progress after the time EPA personnel first occupied their offices. He wanted to know what air-data we had on this activity.

4.5. An IAQ-survey, and Attaining and Maintaining Confidences.

Several people asked about the extent and timing of the survey.

4.6. A Map to Identify Problem Areas.

One of the prior speakers suggested using a map and format to identify locations with heating, ventilation and any other problems.

4.7. Ventilation on the 11th Floor Raised As A Concern.

A new speaker said that it seemed to her that part of the 11th floor was not adequately ventilated, it was stuffy.

4.8. Dry Air Causing Problems, and The Use of Humidifiers.

Many of the participants complained of dry indoor air and the bad (skin, eye, throat) effects it was having on them. One asked if she could use a humidifier in her office.

5. Responses. And Additional and New Information.

All of the points raised were responded to by the writer as they were made. The responses provided, and additional and new information are presented here.

5.1. Re: Issues of Lead in Drinking Water.

The responses made at the meeting, and additional and new information, are:

(A). The "less than 6 micrograms per liter of lead" term used was a direct quote from the laboratory report. Also, the point was made that a periodic lead test had been had been recommended in the Supplementary Report, dated January 29, 1991.

(B). A point of new information is that the chemist (who made the analysis and reported the results using the term "less than 6 microgram/liter") was contacted on 2/1/91 by the writer to discuss the matter of reporting. He said that:

- He used the updated Atomic Adsorption/Furnace method which is EPA-approved (at 40 CFR parts 141 & 142).
- He follows the EPA's Environmental Monitoring and Service Laboratory's (EMSL) guidance for the analysis.
- Reference standards are used to optimize accuracy and precision in the analysis.

Writer's Notes:

- Reference standards are made up based on the need to use an appropriate "Practical Quantification Limit" [PQL] to express the "lowest concentration that can be reliably achieved by a well-operated laboratory", as stated in the Federal Register Vol. 53, No. 160, page 31550, Aug 18, 1988. This Register also states -- [the] " PQL is generally about 5 - 10 times the Method Detection Limit (MDL); --- and (b) --- [the] "MDL is 1 ug/l", relative to the AA/Furnace method for lead in drinking water.
- The use of the term "less than 6 ug/l" to express the lowest concentrations evidently meets the referenced regulatory guideline for reliably reporting low lead levels. It is less than the highest PQL (10 ug/l) which could have been used in accordance with the EPA guidance.
- The reference standard concentration of 6 ug/l is 12% of the current Maximum Contaminant Level (MCL); and, 40% of the proposed (15 ug/l) MCL for lead (the writer thinks that the use of this standard concentration to report on the new low lead level of interest is reliable).

- If regulatory standards (MCLs) get more stringent in terms of concentration limits, one might expect to see a drive toward reduced Practical Quantification Limits; however, it seems to the writer that only small (one or two times the method detection limit) gains might be achieved in this regard by laboratories in general.

- The above information explains, at least to the satisfaction of the writer, the matter which was raised.

(C). The (sink) water sample (which was retained by the chemist) which was reported - quoting - as "an unexplained anomaly" was retested in the week of Febuary 3rd, following on requests from several individuals. The report of the retest was "less than 6 microgram per liter."

(D). On the questioned use of lead solder in fountains: since 1986, there has been a SDW-Act regulation banning the use of lead. Almost certainly, every domestic equipment manufacturer and plumbing contractor knows and follows the directive. Not to do so could be devastating to product sales, and would appear to be an apparent willful violation of the SDWA regulation.

Also, the Engineering Manager of the Rubin Company was contacted by the writer on 2/5/91 on the point. He said that their specifications were replete with provisions covering the banned use of lead throughout the water supply system and that they complied with the building code and so certified to the state in the permit process.

In summary, the point made in the Supplementary Report is reiterated; the writer believes that there is no evident problem of lead in the drinking water. And, a periodic sampling for continuing assurance has been and is recommended. However, there easily might be some relevant and important matter of which the writer is not aware. If any specialist believes that an analytical problem or a health risk exists, the matter should be formally communicated to the appropriate manager.

5.2. Re: Assertion of Formaldehyde Concentration Initially Being Excessive

It is not correct to interweave data from different dynamic situations and tests to reach for an answer to what existed when the building was first occupied. Diffusion rate limitation on emissions, the dynamic dilution effect, and the interaction of these two effects dictate (i) the peak concentration at the initial furniture set-up/hvac-operation, and, (ii) the subsequent time vs.concentration curve. This needs to be appreciated. Also, one purpose of the the HMI-commissioned study was to evaluate the peak formaldehyde level in a typical new office arrangement. HMI's evidence showed that no excessive peak level arises; and our offices are (i) more spacious and (ii) more ventilated than the case of the HMI-test. The writer believes that it is not likely that the initial formaldehyde concentrations were excessive, but he does not preclude the possibility since no specific tests were done when we first moved into the new offices;

there did not appear to be any evident need. However, the point now is that at this time there we know that formaldehyde is not a problem. The writer explained these points in the meeting, and said that if anyone would like to discuss the diffusion and turnover(ventilation) effect on concentration and concentration change rate we could do this.

5.3. Re: Respiratory Hazard? Carpet Pile "Balling."

Jeffrey Davidson, EPA Indoor Air Quality Consultant, pointed out that the carpet pile "balls" and fibers would not be respirable because of their size. The writer pointed out that (i) fibers one sees are not ones to worry about. It is the 5 micron and somewhat longer microscopic fibers that deposit to varying degrees in the compartments of the respiratory system, and even then, the microscopic fibers are not necessarily toxic or their inhalation hazardous; and (ii) he had microscopically examined two, good-sized air samples for respirable dusts, and had found the air to be very clean. The fiber and total particulate loadings on the test filters were very little, and (iii) the there was no evidence that carpet (nylon) fibers were present in the air to a degree which would alarm an industrial hygienist in any way. And, apart from this, nylon fiber is classified as "benign."

5.4. Re: On-Going Construction At the Time Of Occupancy.

There are no air data for the time period. No testing took place. However, the materials involved were common variety and are not considered to be toxic. No hazardous situation is believed to have existed. As additional information, which was not said at the meeting, the writer inspected the 11th floor work at the time and he did not see any problem. He did see that plastic sheeting was being used extensively to control dust spreading, and that the day-time cleaners were making sure that plaster-dust did not track. The construction work in case was done very cleanly, in the opinion of the writer.

5.5. Re: Perceived Problems of Area Ventilation (the 11th floor).

The CO_2 testing showed a high degree of ventilation with respect to fresh air circulation on both floors. Also, the VOCs concentration reported by the Lexington Laboratory for the area in case was only a few parts per billion, in total. It is possible that imbalance or reduced "throw" from a local diffuser in small office areas exists. This might cause the perceived problem. The use of the surveys which we plan to conduct shortly (please see sections 5.6 and 5.7) should be useful in identifying any localized problems. This matter was referred to the Facilities Branch Chief by the writer on 2/4/91).

5.6. Re: The IAQ - Survey.

It was stated that this survey was ready to use (see copy attached), and it would be sent to all EPA employees in the building. P. Meaney will be writing to all employees on this matter. Also, only Dr. O'Campo will handle the responses to assure that confidences are maintained.

5.7. Re: Use of A Floor Plan To Identify Issues.

The proposal to use an annotated floor plan to identify perceived problem areas, to help management in making any necessary changes, without disclosing identities was instantly endorsed by everyone at the meeting. Useful, timely information could be given directly to the facilities specialists.

Floor plans, made by W. Holbrook, already exist which could be used for this purpose after a few minor changes have been made. The writer said that he would make a layout-and-format, which facilities personnel could use as a questionnaire. This questionnaire, of course, would not have any sections addressing medical or personal identification matters. This work is now complete (see copy attached). A facilities-questionnaire is now ready for release. It could be distributed as the same time that the IAQ-Survey is sent out.

5.8. Re: Dry Air and The Use Of Humidifiers.

Dry air in offices was widely recognized as a periodic, winter-time problem. It was stated that no engineered solution was feasible. However, humidifiers might be useful, and there was no current prohibition on their use, provided that the circuit was not overloaded, and the humidifiers were kept clean.

As a point of new information, we can quickly test relative humidity and (dry bulb) temperature before and after using a humidifier in a closed office to see if such use is effective (please call N. Beddows, 565-3388 if you want this done).

N.A. Beddows
2/8/91.

Distribution:

W. Andrade/M.Dowling.
Branch Chiefs (building)
W. Chenoweth.
J. Davidson.
H. Davis.
Division Directors/Senior Staff.
EPA HQ OHSS Staff.
A. O'Campo, M.D. US.PHS.
Participants & Panel Members.
T. Spittler/P.Kahn.
B.White.
EPA Reception Areas,
Floors 10 & 11.

Attachments:

1. Overviews Used 1/31/91.
2. Occupational Medicine IAQ-Questionnaire.
3. Questionnaire For Use By Facilities Specialists.

VIEW-GRAPHS FOR THE UPDATE MEETING OF 1/31/91.

UPDATE -

INDOOR AIR QUALITY

EPA OCCUPIED SPACES,

ONE CONGRESS STREET

N.A. Beddows. 1/29/91.

-DECEMBER 21, 1990 MEETING-

MAJOR CONCERNS ADDRESSED AT THAT TIME - -

- **CO GAS - INFILTRATION FROM GARAGE**
- **CO_2 GAS - MEASURE OF VENTILATION**
- **FORMALDEHYDE - MEASURE OF CONTAMINATION VIA FURNITURE OUTGASSING**

- NEW QUESTIONS ON DEC. 21. 1990 -

- HVAC SYSTEM TYPE & FRESH AIR SUPPLY.
- DUST COMPOSITION -MINERAL FIBERS
- VOCs FROM THE HMI-FURNITURE
- IAQ SURVEY (NIOSH FORMAT)

- SIX POINT PURPOSE -

1. PRESENT DATA GIVEN AT 12/21/90 MEETING

2. REPORT NEW INFORMATION & DATA

   * FURNITURE MATERIALS & OUTGASSING

   * TARGET VOCs

   * DUST SUSPENDED IN AIR

3. DISSEMINATE PRIOR INFORMATION ON LEAD IN THE DRINKING WATER

4. DESCRIBE/DISCUSS THE HVAC SYSTEM & ACTUAL VENTILATION and STANDARDS

5. IDENTIFY CURRENT PROBLEMS and OPPORTUNITIES

6. SUMMATE KEY POINTS

-CARBON MONOXIDE-

FOUND (TOM SPITTLER):

- < 1.0 PPM (0.9) IN OFFICES
- 5 PPM IN SMOKING ROOM.

CARBON MONOXIDE STANDARDS:

- OSHA - INDUSTRIAL STD
  = 50 PPM, TWA.

- EPA / NAAQS - 8HRS: 9 PPM

- WRITER'S "STD" -

  OFFICES, NON SMOKING: 2 PPM.

  SMOKING ROOM: <10 PPM (PEAK).

-CARBON DIOXIDE-

FOUND (TOM SPITTLER):

- 360 PPM

STANDARDS:

- OSHA - INDUSTRIAL STD.
  = 5000 PPM !
  (ASPHIXIATION RISK)

OTHER CARBON DIOXIDE STANDARDS:

- INDUSTRIAL HYGIENE CONSENSUS (IAQ) < 800 PPM, "ACCEPTABLE."

- ABOVE 1000 PPM -- PROBLEMS OF AIR SUPPLY / OVERCROWDING.

-FORMALDEHYDE-

FOUND IN NOVEMBER, 90

NAB / MA. STATE TESTS:

- OPEN FLOOR/5 DAY SAMPLE:
  18 PARTS PER BILLION (PPB)

- CLOSED OFFICE/5 DAY SAMPLE:
  23 PPB

FORMALDEHYDE FOUND IN SECOND SERIES OF TESTS - DEC. 90.

NAB / HPLC & 2,4 DNPH-DOSIMETRY:

- RANGE (n =11) = 10 - 18 PPB and

  GEOMETRIC MEAN = 14 PPB &

  GSD = 1.3.

STANDARD (IAQ - MA STATE)

ACTION LEVEL = 50 PPB.

NOTE.

50 PPB IS THE ODOR LIMIT OF DETECTION FOR MOST OF US.

HERMAN MILLER INC.
COMMISSIONED STUDY:

FORMALDEHYDE & VOCS - MID 1990.

- TYPICAL NEW SET UP. FULL SIZE CHAMBER.
- FORCE VENTILATION & 2.5 AIR CHANGES PER HOUR
- TEMP. (70°F) & HUMIDITY (R.H. 50%) CONTROLLED

HMI FURNITURE STUDY FINDINGS.

- FORMALDEHYDE PEAK = 15 PPB &
  40 DAY HALF-LIFE.

- TVOCs PEAK =
  250 UG/CUBIC METERS* &
  5 DAY HALF-LIFE.

---

* USING O,M,P XYLENE AS A "SURROGATE", THIS EQUALS 57 PPB.

- VOCs BY PORTABLE GC/PID. -

FOUND IN JANUARY (SPITTLER& KAHN):

- BENZENE. TOLUENE. TCE.
- <5 PPB LEVEL FOR EACH

NO CHEMICAL ODORS
IN WORK PLACE

STANDARDS for the COMMON GARDEN VARIETY VOCs:

WASHINGTON STATE (1989) TVOC STD.

KNOWN VOCs; 500 UG/CUBIC METER*

---

* FOR SURROGATE: o,m,p, XYLENE, THIS = 115 PARTS PER BILLION.

- DUSTS BY PLM, 400X -

DECEMBER 28, 1990.

FINDINGS - 1900 LITERS/200 FIELDS/NAB.

- NO MINERAL FIBERS
- NO XTALLINE ROUND PARTICLES
- COMMON VEGETABLE, ANIMAL, & SYNTH. FIBERS PRESENT, also
- VEGETABLE 10 MICRON "ROUNDS" ?

-CONFIRMATION, 12/28/90 FINDINGS-

- CONFIRMED INDEPENDENTLY, ON 1/8/91.
- ALSO, MINOR AMOUNT OF POLLEN & STARCH FOUND

H. DAVIS, EPA LEX. LAB.

-LEAD IN DRINKING WATER (FOUNTAINS)-

NOVEMBER, 1990 TESTS.

FOUND (EPA LAB TESTS):

"BELOW 6 MICROGRAMS/LITER."

D.W. STANDARDS:

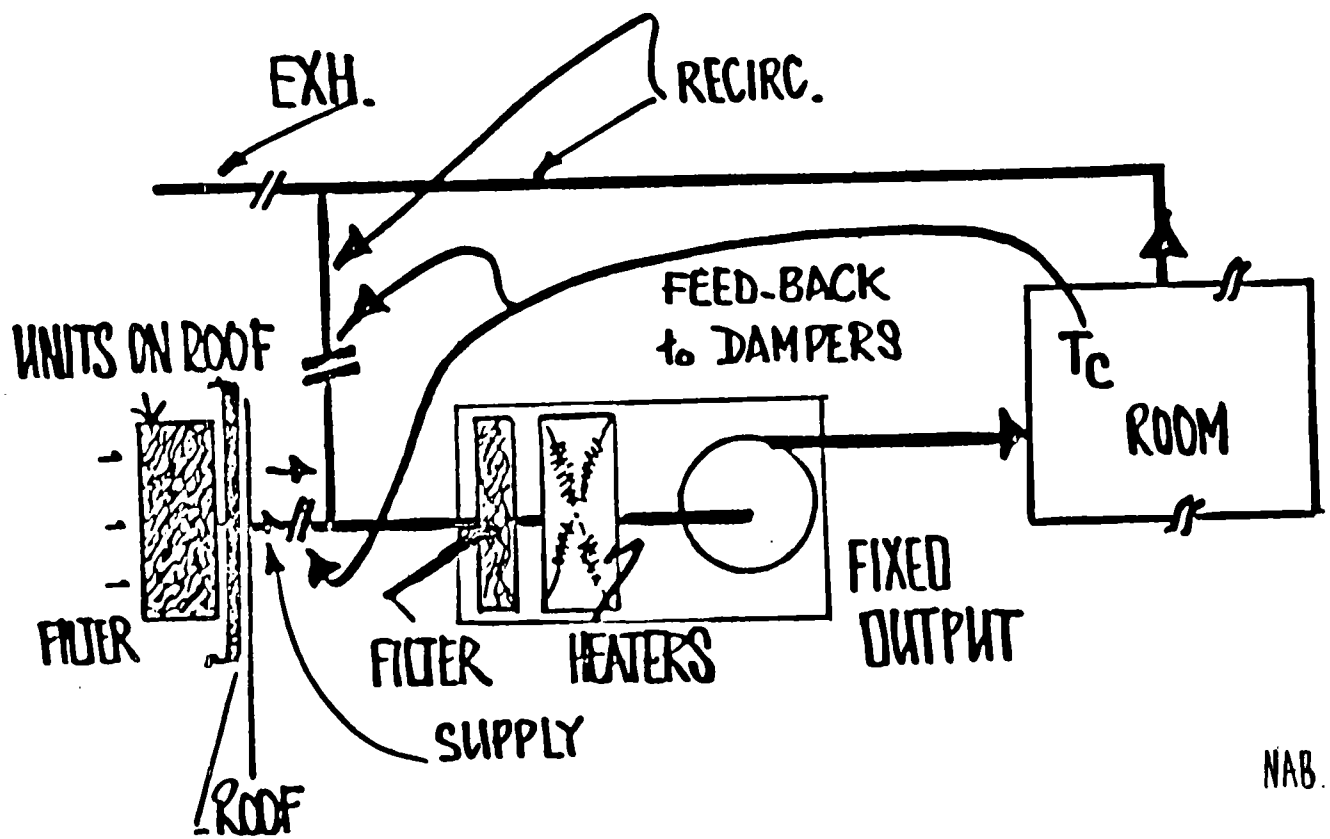
NOW = 50 MICROGRAMS/LITER
SOON = 15 " "

-VENTILATION & AIR CHANGE RATE-

- NAB INSPECTION & (CONSERVATIVE) CALCULATION
- VENTILATION (OUTSIDE AIR) = 25 CFM, PER PERSON
- AIR CHANGE RATE = >4 PER HOUR.
- VENTILATION IS RATED EXCELLENT

ASHREA STD ('89) = 15-20 CFM/PER.

SCHEMATIC OF A TYPICAL VAV - UNIT (168 IN THE SYSTEM)



NAB. 21591

-CURRENT PROBLEM AREAS-

- TEMPERATURE DISTRIBUTION, HORIZONTAL & VERTICAL
- DIRECT LIGHTING - TOO LITTLE & TOO MUCH
- INDIRECT LIGHTING
- NOISE IN SOME AREAS
- VERY DRY AIR PERIODICALLY.

NOTE.

TEMPERATURE BALANCE IS
NEEDED IN SOME LOCATIONS
AT THIS TIME.

- IN SUMMATION -

- NO FORMALDEHYDE GAS OVER-EXPOSURES.
- NO CO, CO_2, VOCs - PROBLEMS.
- NO DUST (FIBERGLASS) PROBLEMS.
- NO LEAD IN DRINKING WATER
- VENTILATION IS EXCELLENT.

- PROBLEMS ARE LOCALIZED re:
  - DIRECT & INDIRECT LIGHTING
  - TEMPERATURE CONTROL
  - NOISE and SPEECH PRIVACY
- AIR DRYNESS IS A GENERAL, Winter - period PROBLEM

- REPORTED/REFERRED COMPLAINTS, FROM FIRST DAY TO DATE.

  - <1% OF ALL EPA EMPLOYEES IN BUILDING.

  - NOT "OCCUPATIONAL ILLNESS", under OSHA.

LETTER OF REQUEST: QUESTIONNAIRES.

1. Medical Questionnaire.
2. Facilities Questionnaire.

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION I
J.F. KENNEDY FEDERAL BUILDING, BOSTON, MASSACHUSETTS 02203-2211

MEMORANDUM

DATE: February 15, 1991

SUBJ: Indoor Air Quality Assessment - Questionnaires

FROM: Patricia L. Meaney, ARA
for Planning and Management

TO: All EPA Employees - One Congress Street

We have been busy in the last few months in evaluating the indoor air and work place qualities in the space which we occupy in this building. Norm Beddows (Industrial Hygienist), Tom Spittler (Laboratory Director) and Peter Kahn (Chemist) have provided reports on the chemical analyses, ventilation study, and exposure assessments which they made. We have held two employee-briefings and provided two comprehensive reports to you.

For the most part, the results have been encouraging. No significant levels of carbon monoxide, formaldehyde or volatile organic compounds were found anywhere on our floors. The carbon dioxide level was very low compared to the levels generally measured in office spaces.

At this time, we have completed the physical-chemical evaluations, and are entering a new phase which involves learning in detail what we can about individual work places. To do this, we need the help of all of you -- those who have complaints or concerns, and those of you who do not. We need you to take a few minutes to answer each of the two questionnaires attached. One questionnaire deals with occupational-medical matters, and the other, with facilities-type questions. We need answers to both of these to be able to give you the best work places that we can, as soon as we can. I will make certain that your answers are held in confidence, as some of you have requested. Please help us to complete our study. I am looking forward to receiving your opinions and thoughts. I promise to let you know about your collective views.

Please send the completed facilities questionnaire to Bill Chenoweth (PFM), and the occupational medical-IAQ questionnaire, to Dr. Alvero O'Campo, Medical Director (DFEOH) Room, E-120 JFK Federal Building, Boston, MA 02203.

Thank you.

Attachments (2).

---

cc: Norm Beddows.
Bill Chenoweth.
Dr. A. O'Campo.
Laurel Seneca.

WORK PLACE QUALITY/FACILTIES QUESTIONNAIRE: FOR EPA EMPLOYEES, ONE CONGRESS STREET.

We need your help to ensure that optimum work place quality is provided to all EPA employees in One Congress Street. You can help by completing this questionnaire and marking any problem area on the floor plan on the reverse side. We need everyone's response, even if there is no particular problem to report. You need not sign the return or indicate your identity in any way. Thank You. Please send your response directly to:

Mr. W. Chenoweth, Facilities Branch Chief, Mail Code: PFM.

PLEASE REPLY BY FEBUARY 21, 1991. THANK YOU.

Do you have any complaints in your work place? Yes ___ No___.
If yes, check the appropriate place, and mark the area on the floor plan.

Temperature too cold___ too hot___

Dust in air___

Odors Noticed___

Voice Transmission/Lack of Essential Business Privacy___

Disturbing Noise/Voice Intrusion___

Direct Lighting too low___ too high___

Glare is a Problem___

Other & Comments (explain) _____

When Do These Problems Occur? (e.g., AM/PM/ Specific Day or Period)

_____

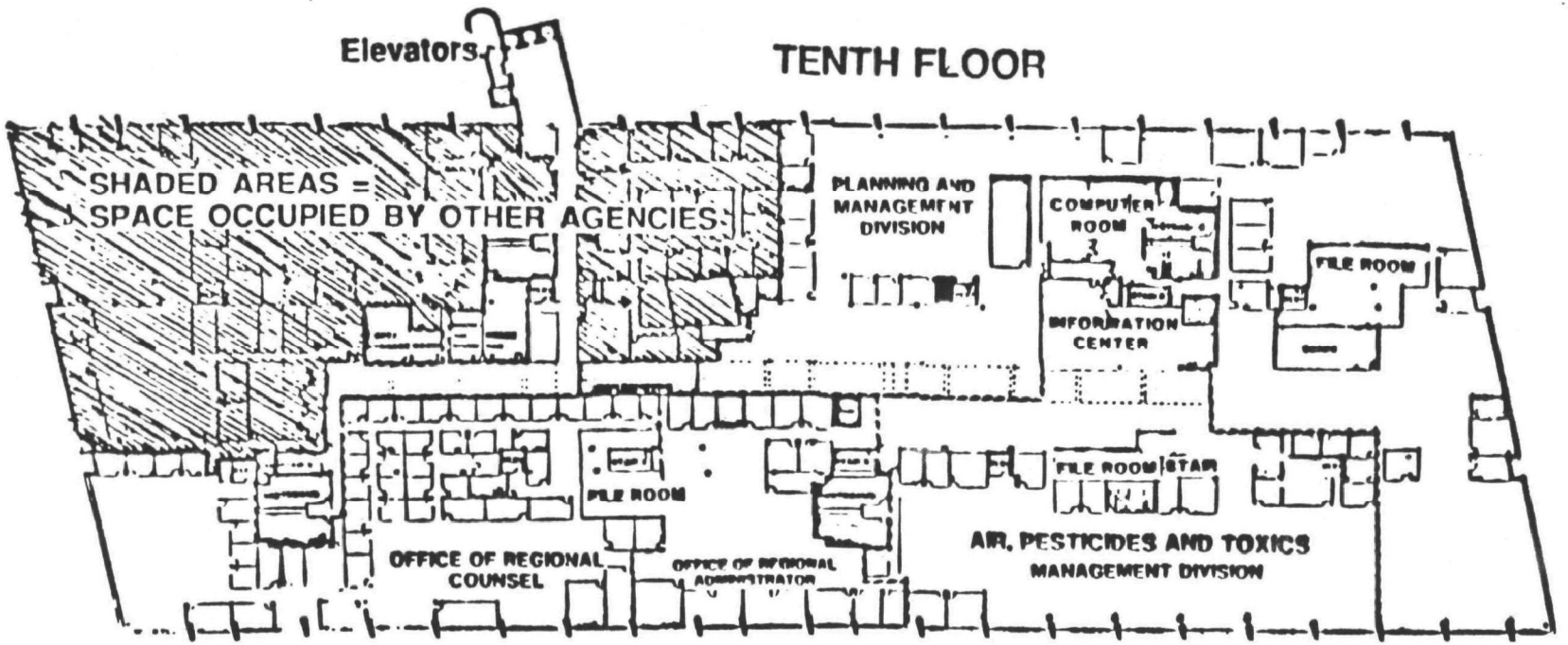
Please use the space below to make any additional remarks.

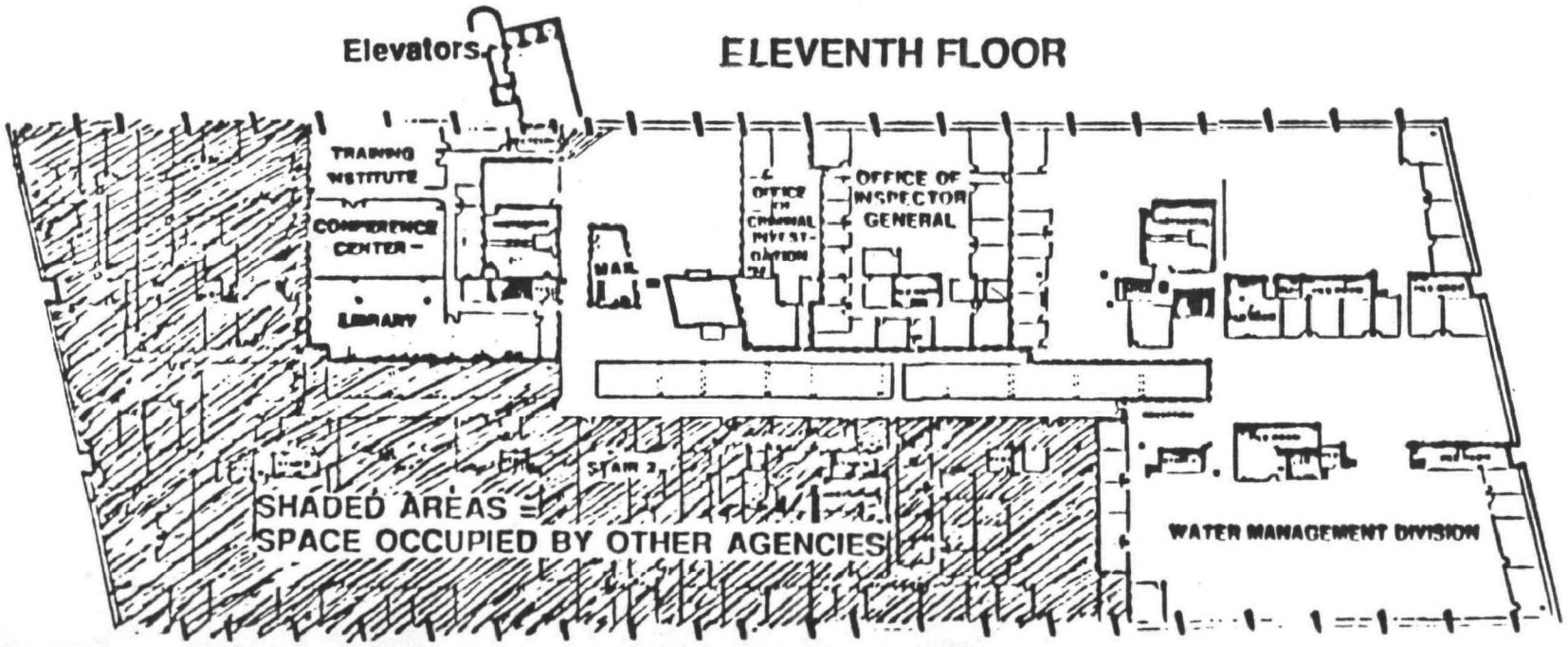
Date___/___/___.

Form NAB(Q.1)1.10.91.

BASIC FLOOR PLANS, EPA OCCUPIED SPACES

PLEASE CIRCLE and APPROPRIATELY IDENTIFY THE AREA OF CONCERN.





OCCUPATIONAL, MEDICAL QUESTIONNAIRE for Occupants of EPA Space, One Congress Street, Boston, Ma.

Please sent your response IN A SEALED ENVELOPE directly to:

Dr. A. O'CAMPO, MEDICAL DIRECTOR
PHS - DIV. OCC. EMPL. HEALTH,
JFK FEDERAL BUILDING, ROOM E 120
GOVERNMENT CENTER, BOSTON, MA. 02203

PLEASE REPLY BY FEBUARY 21, 1991. THANK YOU.

---

1. Do you have any complaints re: your work place environmental quality or related effects? Yes ___ No ___. If yes, please check:

_____ temperature too cold
_____ temperature too hot
_____ lack of air circulation (stuffy feeling)
_____ noticeable odors
_____ dust In the air
_____ disturbing noises
_____ other (specify)

_____

2. When do these problems occur?

_____ morning
_____ afternoon
_____ all day
___ no noticeable trend

_____ daily
_____ specific day(s) of the week
which day(s) _____

_____

3. Health Problems or Symptoms

Describe in three words or less each symptom or adverse health effect you experience more than two times per week. Example: runny nose.

Symptom #I _____
Symptom #2 _____
Symptom #3 _____
Symptom #4 _____
Symptom #5 _____
Symptom #6 _____

Do you have any health problems or allergies which might account for any of the above symptoms? Yes ___ No___. If yes, please describe._____

Do any of the following apply to you?

___wear contact lenses
____operate video display terminals at least 10% of the work day
____operate photocopier machine at least 10% of the work day
____use or operate special office machines or equipment (specify)
_____

5. Do you smoke? Yes ____ No ____

6. What is your job title or position? (optional)
_____

7. Briefly describe your primary job tasks.
_____

_____

8. Your office phone number is? (optional) _____

9. Your name is? (optional) _____

10. Date of this report? __/__/__

IS YOUR REPLY TO BE KEPT CONFIDENTIAL? YES __ NO__.

LETTER TO THE OCCUPATIONAL PHYSICIAN.

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION I
J.F. KENNEDY FEDERAL BUILDING, BOSTON, MASSACHUSETTS 02203-2211

DATE: February 14, 1991.

TO: A. O'Campo. MD.
Director of FEOH Division,
US. PHS, J.F. Kennedy Building,
Boston, MA.

FROM: N.A. Beddows. NA Beddows February 14th 1991.

SUBJECT: Distribution of Medical Questionnaire.
Program Information & Requested Feedback.

Today, the medical questionnaire (a facsimile of the NIOSH-EPA Indoor Air Medical Questionnaire) was sent to all the EPA's employees at One Congress Street, with a request that they send their responses directly to you so that we can assure that they are held in confidence and competently evaluated, as you so kindly agreed to undertake.

I expect that there will be some respondents, and that some of these may have had field-assignments with EPA Region 1. If this is so, they will most likely have participated in the Regional medical monitoring program, for which I am the project officer. You may wish to have access to a medical record which we might have under this program so that you may better gain an understanding of any reported disorder or aggravation of a disorder. If this is the case, we would require a simple written permission from the respondent, addressed to myself (contractually, such releases from the contract physician are required to be handled in this manner). Once this is in hand, I will arrange for any record to be made available.

We are sending you under separate cover, a consolidated report of the evaluations and transactions relating to the indoor air quality assessments made here in recent months.

I am confident that the responses will be thoroughly reviewed and concisely reported upon. For our purpose, to assure that we are providing optimum work place safety, I would need to know how many returns are delivered to you, and what types, and how many of each type, of disorders or aggravations of pre-existing disorders there are reported in the total number of returns. No disclosure of identities would arise in any way in this context. Of course, any and all additional information which you can provide to us while assuring that confidences are maintained will be most welcome. Also, employees can make requests for information or consideration directly to the management.

If you need further information, please advise. My telephone number is 565-3388. Thank you.

---

cc. Barbara White. Laurel Seneca.
Julius Jimeno. Patricia Meaney. William Chenoweth.

CURRENT INFORMATION FROM
THE QUESTIONNAIRES.

SUMMARY OF REPLIES TO QUESTIONNAIRES.

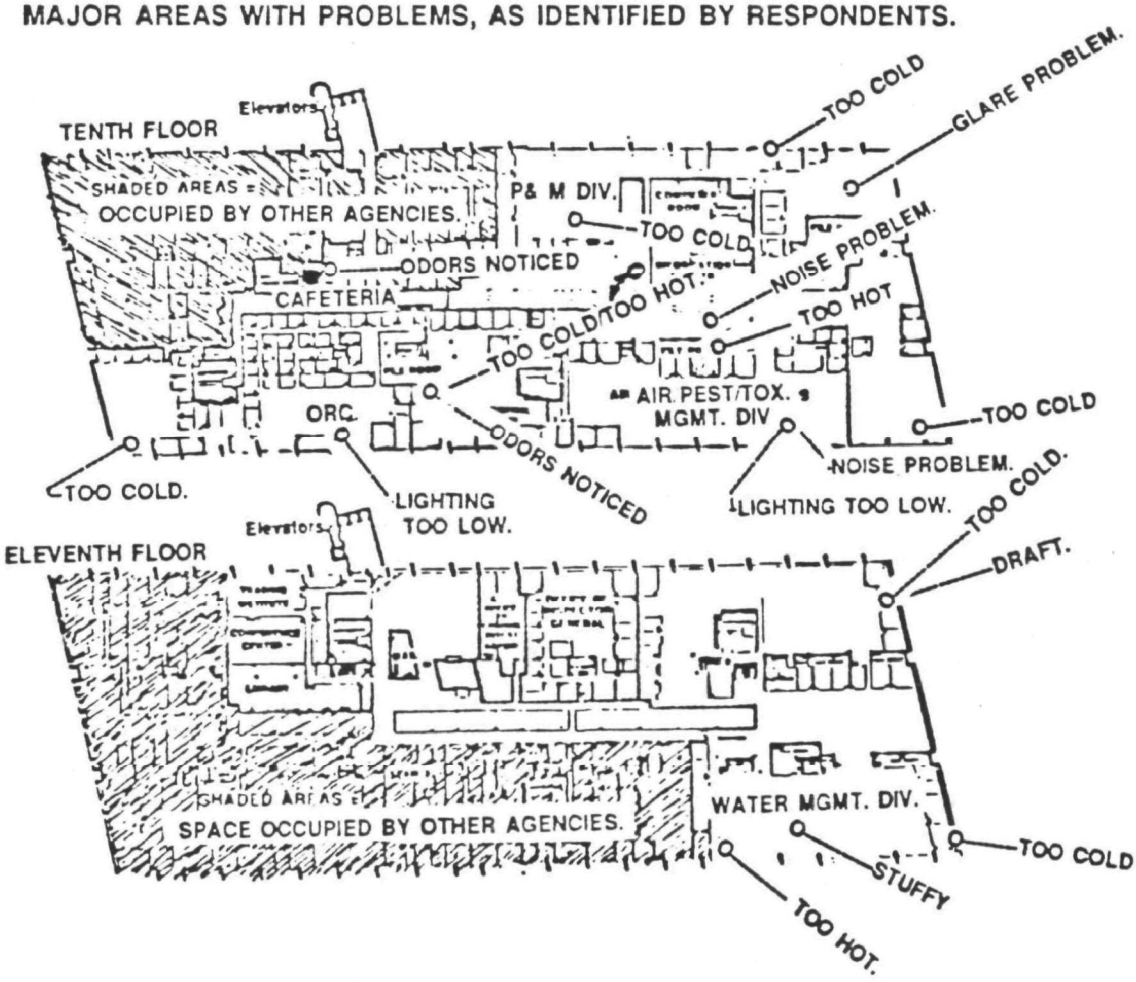
700 copies of both the facilities and medical questionnaires were made available to all employees at One Congress Street, by direct mailing to all (EPA'/EPA-contractor's) employees in the building, and distribution at the reception areas. There are approximately 600 potential respondents. The single or multiple complaints, either about the conditions or symptoms, are summarily stated below. The summaries are based on (i) the reports sent to the Facilities Branch, and (ii) the oral summary report provided by the physician on 2/25/91 to the writer.

1. REPLIES TO THE FACILITIES-QUESTIONNAIRE.

COMPLAINT	LOCATION 10TH	11TH	(FLOOR)	AFFECTED AREA(S)/DIVISION(s)
• TEMP. TOO COLD.	18	03	21	Corner Offices,
• TEMP. TOO HOT.	08	02	10	10 and 11 floors
• DUSTY.	oo	00		
• TOO NOISY.	16	07	23	Central Aisle (10)
• ODORS PRESENT.	06	00		
• TOO MUCH LIGHT.	00	00		ORC office/Cafetaria
• TOO LITTLE LIGHT.	04	02		
• TOO MUCH GLARE.	06	00		General
• AIR DRYNESS.	01	01		11 floor, WMD.
• STUFFY AIR.	02	01		
• OTHER.	00	00		
SUM OF COMPLAINTS:	61.	16	COMPLAINTS RECEIVED, AS OF 2/25/91:	61.
WRITE-IN COMPLAINTS:				

Please See Attachment re: typical comments.

MAJOR AREAS WITH PROBLEMS, AS IDENTIFIED BY RESPONDENTS.



REPRESENTATIVE WRITE-IN COMPLAINTS

(NOT ALL INCLUSIVE)

10th fl. P&M Div. FAR CORNER WALL. Also 11 th fl. WMD. Wall Area: "temperature too cold, all day...when cold outside" (multiple same comments).

11th fl. WMDiv. "noise is incredibly disruptive---biggest factor on productivity, overrides all the other factors."

Both floors/Open Offices: "managers should go tell noisy people to keep it quiet. "Info branch should get covers for all the noisy, chartpaper printers on the open floor offices. People should use them"

10th fl. AIR Div. Int. Space: "lighting too low all day"

11th fl. AIR Div. Central Area: "this area is noisy all day---it's noisy everywhere."

10th fl. ORC: "no lighting above my work area."

Special Notes Re: Air Movement on part of the 11th Floor

1. Because of the total number of the "write-in" and verbally made comments on the point of perceived stuffiness on the 11th floor, WMD, central area, the writer discussed the matter with the building engineer on 2/21/91. He provided the following information:

   "The motor to the VAV in this area is burned out. [He is] waiting for a replacement motor. The area [in point] was not completed by the HVAC-contractor." (who went bankrupt). "Two diffussers and associated ducts are missing. Arrangements have been made to correct the problem. A contractor [was] in the building today."

2. Based on the above information, the complaint of stuffiness (no air movement) in the affected area is probably valid. Actual ventilation of the floor area, however, is judged to be satisfactory by the writer based on (1) the fact that the floor area is generally open, and (2) the carbon dioxide tests in December and the VOC(s) tests in January showed a consistent level of (good quality) ventilation, and a low contamination situation.

NAB.

2. Information From The Occupational Physician.

Dr O'Campo, Medical Director, Division of Federal Employees Occupational Health, provided the writer with a comment that about 100 responses to the medical questionnaire have been received, and that he has sent the responses for analyses to a colleague. Dr O'Campo said that he would try to provide a summary for distribution to our employees in the near future. At this time the writer has no data on the resonses made to the medical questionnaire. Dr O'Campo will provide a written report later.

NAB. 2/26/91.

III. GENERAL DISCUSSION.

Back-ground information is provided in the summary report dated 12/21/90, and in the supplemental report dated 1/27/91. Some of this information and new points are discussed herein.

1. Volatile Compounds Found Indoors. Target Compounds. And On-Site Analysis.

The presence of many hundreds of volatile and semi-volatile compounds, very small concentrations, could be found in office buildings if ultra-sensitive detection (GC-MS) were employed (Characterization of VOCs in Public Access Buildings, Sheldon, L.S. 1987).

The volatile organic compounds that would be likely to be found in new office buildings are common compounds which are members of the following chemical classes:

- o **Aliphatic Hydrocarbons** (e.g., n-decane, undecane, cerene, limonene). Painted sheetrock, glued carpet, and office furnishing are common sources.
- o **Aromatic Hydrocarbons** (e.g., toluene, benzene, styrene, ethyl benzene, trimethyl benzene). Glued carpet and wall covering are common sources.
- o **Halogenated Hydrocarbons** (e.g., tetrachloroethylene, 1,1,1-trichloroethane, trichloroethylene, dichlorobenzene, chloroform). Cleaning agents and insecticides are common sources.
- o **Aldehydes** (e.g., formaldehyde). Furnishing is the major source.

Other classes (e.g., organic acids, alcohols) may also exist in some situations.

The concentrations of the compounds actually present will depend largely on the types and quantities of furnishing, the age of the installation (with time, concentrations decrease), and the ventilation rate.

Many of the common, room-temperature volatile compounds of these four major classes can be analyzed and quantified on-site, at the parts per billion level, using a portable gas chromatograph with a photoionizing detector. Essentially, the compound of interest need have an ionization potential equal or less than the energy of the detector (nominally, 10.2 ev.) and be relatively responsive to the ionization detector. Hydrogen cyanide (IP, 12.8 ev.) and carbon dioxide (IP, 14.1 ev.) are not detected by PID.

Benzene and toluene which are ubiquitous can be identified and quantified using a GC-PID instrument and carefully prepared, and validated "head-space" reference standards* at about half a part per billion (the outside city air could contain one part per billion v/v of each of these compounds; meta and para xylenes, at about one part per billion; and tetrachloroethylene, at about one part per billion.

---

* If an accurately known, very dilute solution of a sparingly soluble volatile organic compound in water (TC, wt/vol. unit) completely fills a capped vial, and the a fraction (F) of the solution is withdrawn and discarded, The volatile compound partitions itself between the air and the water so that an air concentration (A, wt/vol.) is established at the prevailing equilibrium conditions. The relationship is: $TC/A = 1/K + (F/1-F)$. "H" is Henry's constant, which is temperature dependant. In practice prepared solutions (fully filled vial) are kept in ice until needed, and a micro syringe is used to sample the head space and inject the sample into the GC column. The GC has a control for selecting an appropriate scale.

In a well-ventilated, well-regulated office, one might expect to encounter toluene concentrations of less than ten parts per billion; and benzene, at less than five parts per billion. However, in a smoking room, the concentrations of these compounds (and carbon monoxide) could be at least an order of magnitude greater than the respective non-smoking office levels.

Employing benzene, toluene, o,m, p xylenes, trichloroethylene, chlorobenzene and other several other common volatile compounds (which have ionization potentials at or below 10.2 e.v) as target compounds for evaluating indoor air quality using a portable GC-PID unit is both appropriate and convenient. In this way, one can quickly evaluate both the (air) quality of a space, and the consistency of quality of a large space, and determine if an facility or operation (for instance, a cafeteria, a smoking room or a printing room) is causing or contributing to a localized air quality problem.

Formaldehyde is a common contaminant of interest. It can be quantified (with a practical limit of a few parts per billion) quickly and inexpensively using a one-day exposure dosimeter and high performance liquid chromatography (for more information, please see the supplementary report dated 1/29/91).

Carbon dioxide (an index of effective ventilation) and carbon monoxide (an indicator of a problem of infiltration from a garage operation, or ineffective ventilation of a smoking room) can be quickly and inexpensively quantified, with adequate sensitivity for these purposes, using a portable infra-red (Miran) analyzer. for more information, please see the summary report dated 12/21/90.

2. Office Characteristics. New Office Treatment.

When it comes to indoor air and work place environmental quality matters, we know that forced ventilation and freedom from respirable particulate and organic compounds are essential. Also, direct and indirect lighting, relative humidity, temperature, and air velocity are major factors. Work place noise can be important. For the most part, these factors are easily quantified, and can be related to occupants' perceptions of their well-being. We are also aware of the role that microbiological agents can have in work place safety. What is much less evident, is the relationship of sub-clinical effects to repeated daily exposures to the hundreds of volatile organic compounds which may be identified in indoor air at fractional parts per billion or parts per billion concentrations when at sophisticated analytical methods are employed. What effects exposuress to a low total concentration of a mixture of aliphatic, aromatic and chlorinated hydrocarbons (the dominant classes of volatile compounds which could be found in office air) and alcohols, acids, ketones, aldehydes and esters (which may also be present in office air) at sub-parts or a few parts per billion levels) may have on occupants appears to be essentially unknown, despite the fact that such exposures have been implicated in sick building syndrome scenarios.

New buildings are expected to have greater initial concentrations of volatile compounds in the air than they would have several months later. Some researchers (Pellizzari, 1984; Wallace et al, 1987) have demonstrated that several orders of magnitude differences between the initial concentrations and the concentrations several months later, of some simple aromatic and aliphatic hydrocarbons, can occur. Also, correspondingly, half-lives of several weeks to several months can occur.

Each situation is matter of dynamic mixing of emitted vapors and fresh air supply. The types and extent of furnishing used and the turn-over time for the building-ventilation dictate what will be the initial concentrations and concentration decay rates in each case. So, it seems prudent to maximally air out any new building before occupancy, and to continue airing out even after occupancy. There is obviously a limit to doing this; its an economic limit, essentially, and one which should be carefully thought about by the building owners and others.

3. Noise In The Work Place.

Noise is an evident problem in some spaces. Engineered solutions may be available in some instances, sound absorptive panels and other devices. A correct approach to noise control calls for the services of an acoustic engineer. However, some solutions are self evident. The provision of computer-printer, acoustic covers, and proper personal behavior, including properly using the telephones for business communications will improve the work place quality for many of the occupants.

4. Economic Considerations of Indoor Air Quality Evaluation.

It is abundantly clear that evaluating indoor air quality is potentially very expensive. It is interesting to briefly look at potential costs. The consultant certified industrial hygienist rate is $100 - $120 per hour; the consultant analyst rate is $60 to $80 per hour, depending on the services rendered; and other needed ancillary services are, typically, $30 to $35 per hour. An IAQ-evaluation, encompassing the minimal scope of the evaluations reported herein, requires, as a minimum, the following levels of services: 200 hours, industrial hygiene time; 60 hours, analysts' time; and 40 hours, support services. Thus, one could expect consultants' charges to be about $30,000 for a preliminary but reasonably comprehensive study of a commercial facility comprising several large floors. The economy of using in-house expert services when they exist in conducting an evaluation is evident.

V. SUMMARY OF CONCLUSIONS.

With Respect To Contaminants.
Carbon monoxide, formaldehyde, benzene, toluene, and trichloroethylene have been found in indoor air at One Congress at only trace concentrations. In some cases, the indoor air concentrations were similar to the concentrations found in the street air immediately outside the building (the street air test was: benzene, 1 ppb; toluene, 1.5 ppb, on January 8, the day that the indoor tests were made by T. Spittler and P. Kahn).

The reported sum total of the important target volatile organic compounds which were evaluated, excluding formaldehyde, found in the office air, at any location excluding the designated smoking room on the tenth floor, was less than 7 parts per billion, by volume. The dominant constituent was toluene, at 4 ppb; and, the second dominant compound was benzene, at 1.5 ppb (as a maximum).

Formaldehyde was found in the indoor air. Based on the best chemistry available, using a battery of eleven tests including one control, made in late December 1990, we found the geometric mean concentration was 14 ppb, with a geometric standard deviation of 1.3 (the transition point for a log normal distribution).

The smoking room was found to have elevated levels of carbon monoxide (5 ppm), benzene (30 ppb), toluene (64 ppb), and o,m,p xylenes (12 ppb). These levels are what one would expect for this type of room (with no dedicated forced ventilation).

Carbon dioxide level in the building was less than 400 parts per million. This fact, and the spot checks which the writer made on representative variable air volume (VAV) units, with respect to the minimal fresh air intake rate, and the conservative evaluation by the writer of the total ventilation rate from simultaneously operational VAV-units, indicate that the degree of gross forced ventilation on both floors is excellent.

Dust in air has been shown to be free of inorganic fibers and silica. Dust loading is very light. In one area grains of pollen were found, together with a very light level of paper and organic fibers somewhat larger than respirable size, using an exhaustive microscopic evaluation. The finding of pollen indoors is to be expected, under such an examination. The pollen (the writer's "rounds", in the evaluation of 1/8/91) load level (<100 count) was negligible based on the number of microscopic fields (200, at about 0.006 mm. sq.) examined and the high volume (1900 liters) of air sampled and filtered (using a 35mm dia., 0.8 um pore-size, MCE-filter).

Sub-standard office direct lighting exists in some locations. Localized glare, noise transmission, and temperature swings are evident problems. Ventilation of the smoking room is sub-standard. These problems are being worked on by the facilities branch personnel and the building management. An engineered solution exists for each of the illumination and ventilation problems, and may exist for the other types of problem. Periodic, general low level relative humidity is an evident problem. This is not amenable to an engineered control. Personal practices and local humidification may ameliorate the problem when it arises.

Microbiologic evaluation was not undertaken in the studies to date. There was and is no indication from any EPA experience that this ought to be done. The Department of Labor did conduct such an examination, in December 1990, in an enclosed office on the eleventh floor as part of an evaluation of a work place in response an apparent case of acute urticaria of an unresolved etiology. A report of the evaluation was provided to the writer by the DOL Regional Administrator. The report concludes that there is no microbiological contamination to be concerned about (the remainder of this (DOL) evaluation was consistent with the findings of the EPA studies reported herein).

With Respect To Complaints.
The total sum of currently known (as of 2/28/91) formal complaints involving both claimed occupational exposures is low. The affirmative responses to the occupational medical questionnaire-survey, which might relate to an occupational office exposure is being evaluated by the physician, who will report separately on this matter.

Final Comment.
Based on the preliminary quantitative studies made to date and the respective norms, the writer believes that there are no current recognizable hazards which could be associated in any way with any current level of indoor contamination of any kind. The degree of gross ventilation appears to be excellent. Localized problems in illumination, noise and possibly diffused air flow appear to exist, and air dryness is a general but periodic problem. It is possible that a small number of our work-force is extraordinarily sensitive to either trace levels of contaminants and/or physical conditions in the work place. However, the writer knows of no evidence to date which indicate that occupational (health) hazards exist indoors at One Congress Street.

VI. RECOMMENDATIONS.

On The Point Of Addressing Complaints.
In regard to past complaints asserting only that some aspect of the new work place seemed to cause some minor irritation or level of discomfort, one might accept them at face value. We do not have any period data on relatively low concentrations of potentially irritating substances (formaldehyde, volatile organic compounds or dust) or any physical agent to base a concurrence or dissention. Any past complaint asserting any serious adverse effect casually related to the work place is invidious, knowing what we do know about the facility and its furbishing, and the extensive period of ventilation (airing out) which was employed prior to occupancy. An current complaint from any source ought to be considered fully in terms of any specific and local condition which exists. There evidently are problems in direct lighting, indirect lighting, drafts and temperature drops, and work place noise which may be disconcerting but are not recognizably hazardous. A complaint made to the occupational physician, via the medical questionnaire-survey, ought to be formally responded to, after a competent industrial hygiene assessment has been made.

On Corrective Action.
Issues of lighting, noise, temperature and drafts ought to be systematically corrected. Ongoing facilities-programs appear to be now in place for this purpose.

In regard to work place noise, the use of sound covers for printers is evidently needed in some areas, especially the areas near the atrium and the adjacent offices. Also, administrative efforts appear to be needed to persuade some employees to be less noisy; to use the office telephone for business only; or to hold meetings in conference rooms rather than in open offices or aisles. This could very well be as effective as undertaking an engineered solution to a localized noise problem.

The use of humidifiers in closed offices might be beneficial at times. Care would have to be taken to use a bacteriastat in the water. Also, one would need to make sure that the circuit was not overloaded.

Consideration of force-ventilating the 10th floor photocopy room is recommended.

On Requiring Additional Quantitative Evaluations.
Every employee-complaint should be responded to individually; this may require making a local evaluation. However, absent a significant level of complaints which could be reasonably related to a questionable occupational indoor exposure, further in-depth analyses of volatile organic chemicals including formaldehyde is not justifiable. Further evaluation would require making extraordinary and costly efforts; and even then, the likelihood would be low, in the judgment of the writer, that a meaningful outcome would ensue from the analyses of volatile organic contaminants which might be present a mere trace concentrations. On this point, one simply does not know the toxicological relevance of an observed plethora of common garden variety organic compounds measured at fractional part per billion levels.

APPENDIX TO CONSOLIDATED REPORT

Appendix

1. December, 1990 Formaldehyde Data (Beddows et al).
2. December, 1990 Target VOC Data (Spittler et al).
3. Febuary, 1991 Illuminance Data (Wade, R.).

GMD SYSTEMS, INC.

DECEMBER 26, 1990

U.S. EPA
JFK FEDERAL BLDG
BOSTON, MA 02203

ATTENTION: NORMAN BEDDOWS

ENCLOSED PLEASE FIND A COPY OF THE RESULTS FROM THE FORMALDEHYDE BADGES YOU SUBMITTED FOR ANALYSIS.

IF YOU HAVE ANY FURTHER QUESTIONS REGARDING THESE RESULTS, PLEASE CONTACT GMD.

BEST REGARDS,

Linda Coyne

LINDA COYNE
GMD LAB & RESEARCH MANAGER

ENCLOSURES: FORMALDEHYDE ANALYSIS REPORTS
RKM

Old Route 519 Hendersonville, PA 15339 USA (412) 746-3600 FAX: (412) 746-1359

A BACHARACH Affiliate

SAMPLE IDENTIFICATION

Name: FITZGERALD Location: INSIDE OFFICE

Sample Date: 12/11/90 Sample Number: 5509

Start Time: Stop Time: Duration: 1375min

SAMPLE ANALYSIS

Sample #: 5509 Date:

Results: 0.78 ug (adjusted from blank)

Units: PPB Sample Volume: 34.6 liters

TWA for period: (18) TWA 8 hr: 18 PPB

SAMPLE IDENTIFICATION

Name: BEDDOWS Location: OFFICE FLOOR

Sample Date: 12/11/90 Sample Number: 5510

Start Time: Stop Time: Duration: 1380min

SAMPLE ANALYSIS

Sample #: 5510 Date:

Results: 0.49 ug (adjusted from blank)

Units: PPB Sample Volume: 34.8 liters

TWA for period: (12) TWA 8 hr: 12 PPB

SAMPLE IDENTIFICATION

Name: GOETZL Location: OFFICE

Sample Date: 12/11/90 Sample Number: 5511

Start Time: Stop Time: Duration: 1375min

SAMPLE ANALYSIS

Sample #: 5511 Date:

Results: 0.78 ug (adjusted from blank)

Units: PPB Sample Volume: 34.7 liters

TWA for period: (18) TWA 8 hr: 18 PPB

SAMPLE IDENTIFICATION

Name: ELLS Location: OFFICE

Sample Date: 12/11/90 Sample Number: 5512

Start Time: Stop Time: Duration: 1364min

SAMPLE ANALYSIS

Sample #: 5512 Date:

Results: 0.75 ug (adjusted from blank)

Units: PPB Sample Volume: 34.4 liters

TWA for period: (18) TWA 8 hr: 18 PPB

SAMPLE IDENTIFICATION

Name: DAHL Location: OFFICE

Sample Date: 12/11/90 Sample Number: 5513

Start Time: Stop Time: Duration: min

SAMPLE ANALYSIS

Sample #: 5513 Date:

Results: 0.59 ug (adjusted from blank)

Units: PPB Sample Volume: 34.6 liters

TWA for period: (14) TWA 8 hr: 14 PPB

SAMPLE IDENTIFICATION

Name: ROSENSTEIN Location: BLANK

Sample Date: 12/11/90 Sample Number: 5514

Start Time: Stop Time: Duration: min

SAMPLE ANALYSIS

Sample #: 5514 Date: BLANK

Results: (0.05 ug (adjusted from blank)

Units: PPB Sample Volume: liters

TWA for period: TWA 8 hr:

SAMPLE IDENTIFICATION

Name: KOTELLY Location: OFFICE

Sample Date: 12/11/90 Sample Number: 5515

Start Time: Stop Time: Duration: 1344min

SAMPLE ANALYSIS

Sample #: 5515 Date:

Results: 0.66 ug (adjusted from blank)

Units: PPB Sample Volume: 33.9 liters

TWA for period: (16) TWA 8 hr: 16 PPB

SAMPLE IDENTIFICATION

Name: CHIC Location: FLOOR

Sample Date: 12/11/90 Sample Number: 5516

Start Time: Stop Time: Duration: 1345min

SAMPLE ANALYSIS

Sample #: 5516 Date:

Results: 0.51 ug (adjusted from blank)

Units: PPB Sample Volume: 33.9 liters

TWA for period: (12) TWA 8 hr: 12 PPB

SAMPLE IDENTIFICATION

Name: ECEERY Location: FLOOR

Sample Date: 12/11/90 Sample Number: 5517

Start Time: Stop Time: Duration: 1360min

SAMPLE ANALYSIS

Sample #: 5517 Date:

Results: 0.41 ug (adjusted from blank)

Units: PPB Sample Volume: 34.3 liters

TWA for period: (9.7) TWA 8 hr: 9.7 PPB

SAMPLE IDENTIFICATION

Name: SPINA Location: FLOOR

Sample Date: 12/11/90 Sample Number: 5518

Start Time: Stop Time: Duration: 1370min

SAMPLE ANALYSIS

Sample #: 5518 Date:

Results: 0.64 ug (adjusted from blank)

Units: PPB Sample Volume: 34.5 liters

TWA for period: (15) TWA 8 hr: 15 PPB

QUALITY CONTROL ANALYSIS

Control Blank Analysis: 0.16 ug

INDOOR VOC AIR SCREENING SURVEY RESULTS

EPA REGION I OFFICE BUILDING

ONE CONGRESS STREET - BOSTON, MASSACHUSETTS

JANUARY 1991

A description of the sampling locations used in this survey are described below.

Floor 10

- Cafeteria - One grab sample was collected approximately 5 feet above floor level at 1307 hours in the hall way adjacent to the cafeteria entrance.
- L.B. Area - One grab sample was collected approximately 5 feet above floor level at 1310 hours adjacent to the work station occupied by employee L.B.
- Paul Keough's Office - One grab sample was collected approximately 5 feet above floor level at 1330 hours in Paul Keough's Office.
- B.C. Area - One grab sample was collected approximately 5 feet above floor level at 1335 hours adjacent to the work station occupied by employee B.C.
- Smoking Room - Two grab samples were collected approximately 5 feet above floor level at 1350 hours in the smoking room. At the time samples were collected, the room was occupied by three individuals, 2 were smoking cigarettes and 1 a pipe.

Floor 11

- L.W. Area - One grab sample was collected approximately 5 feet above floor level at 1230 hours adjacent to the work station occupied by employee L.W.
- R.M. Area - One grab sample was collected approximately 5 feet above floor level at 1235 hours adjacent to the work station occupied by employee R.M.
- Library - One grab sample was collected approximately 5 feet above floor level at 1250 hours adjacent to the circulation desk.
- EPA Reception Desk - One grab sample was collected approximately 5 feet above floor level at 1253 hours adjacent to the reception desk.

FLOOR 10 - PAUL KEOUGH'S OFFICE

Compound	Detection Limits (ppb v/v)	Background (ppb v/v)	Sample # 21 (ppb v/v)
Benzene	0.2	1	1.2
Trichloroethylene	0.2	ND	ND
Toluene	0.6	1.5	4.2
Tetrachloroethylene	0.8	ND	ND
Chlorobenzene	2	ND	ND
Ethylbenzene	1	ND	ND
m, p Xylene	1	ND	ND
o-Xylene	4	ND	ND

ND = nondetectable Levels were not detected above method's detection limit.

FLOOR 10 - B.C. AREA

Compound	Detection Limits (ppb v/v)	Background (ppb v/v)	Sample # 22 (ppb v/v)
Benzene	0.2	1	1.2
Trichloroethylene	0.2	ND	ND
Toluene	0.6	1.5	3.6
Tetrachloroethylene	0.8	ND	ND
Chlorobenzene	2	ND	ND
Ethylbenzene	1	ND	ND
m, p Xylene	1	ND	ND
o-Xylene	4	ND	ND

FLOOR 10 - L.B. AREA

Compound	Detection Limits (ppb v/v)	Background (ppb v/v)	Sample # 18 (ppb v/v)
Benzene	0.2	1	1.2
Trichloroethylene	0.2	ND	ND
Toluene	0.6	1.5	3.6
Tetrachloroethylene	0.8	ND	ND
Chlorobenzene	2	ND	ND
Ethylbenzene	1	ND	ND
m, p Xylene	1	ND	ND
o-Xylene	4	ND	ND

Compound	Detection Limits (ppb v/v)	Background (ppb v/v)	Sample # 17 (ppb v/v)
Benzene	0.2	1	1.5
Trichloroethylene	0.2	ND	1.2
Toluene	0.6	1.5	3.6
Tetrachloroethylene	0.8	ND	ND
Chlorobenzene	2	ND	ND
Ethylbenzene	1	ND	ND
m, p Xylene	1	ND	ND
o-Xylene	4	ND	ND

FLOOR 11 - L.W. AREA

Compound	Detection Limits (ppb v/v)	Background (ppb v/v)	Sample # 9 (ppb v/v)
Benzene	0.2	1	1
Trichloroethylene	0.2	ND	ND
Toluene	0.6	1.5	4
Tetrachloroethylene	0.8	ND	ND
Chlorobenzene	2	ND	ND
Ethylbenzene	1	ND	ND
m, p Xylene	1	ND	ND
o-Xylene	4	ND	ND

ND = nondetectable Levels were not detected above method's detection limit.

FLOOR 11 - LIBRARY

Compound	Detection Limits (ppb v/v)	Background (ppb v/v)	Sample # 14 (ppb v/v)
Benzene	0.2	1	1.2
Trichloroethylene	0.2	ND	ND
Toluene	0.6	1.5	3
Tetrachloroethylene	0.8	ND	1.4
Chlorobenzene	2	ND	ND
Ethylbenzene	1	ND	ND
m, p Xylene	1	ND	ND
o-Xylene	4	ND	ND

FLOOR 11 - R.M. AREA

Compound	Detection Limits (ppb v/v)	Background (ppb v/v)	Sample # 10 (ppb v/v)
Benzene	0.2	1	1.5
Trichloroethylene	0.2	ND	ND
Toluene	0.6	1.5	4
Tetrachloroethylene	0.8	ND	ND
Chlorobenzene	2	ND	ND
Ethylbenzene	1	ND	ND
m, p Xylene	1	ND	ND
o-Xylene	4	ND	ND

FLOOR 11 - RECEPTION DESK

Compound	Detection Limits (ppb v/v)	Background (ppb v/v)	Sample # 15 (ppb v/v)
Benzene	0.2	1	1.2
Trichloroethylene	0.2	ND	ND
Toluene	0.6	1.5	3
Tetrachloroethylene	0.8	ND	ND
Chlorobenzene	2	ND	ND
Ethylbenzene	1	ND	ND
m, p Xylene	1	ND	ND
o-Xylene	4	ND	ND

FLOOR 10 - SMOKING ROOM

Compound	Detection Limits (ppb v/v)	Background (ppb v/v)	Sample # 29 (ppb v/v)
Benzene	0.2	1	30
Trichloroethylene	0.2	ND	ND
Toluene	0.6	1.5	64
Tetrachloroethylene	0.8	ND	ND
Chlorobenzene	2	ND	ND
Ethylbenzene	1	ND	ND
m, p Xylene	1	ND	7
o-Xylene	4	ND	5

ND = nondetectable Levels were not detected above method's detection limit.

FOOTCANDLE READINGS

DIV	FLR	W/S		PRI f/c	SEC f/c
ORC	10				
		W	1	30	36
			2	28	38
			3	46	30
			4	36	28
			5	43	26
			6	36	30
			7	22	*
			8	20	*
			9	28	42
			10	40	42
			11	45	40
		W	12	42	45
		W	13	55	50
			14	15	24
			15	34	34
			16	45	45
			17	48	45
			18	32	38
			19	42	42
		W	20	40	32
		W	21	44	60
		W	22	48	70
		W	23	24	28
		W	24	30	44
			25	48	60
			26	30	45
			27	46	44
			28	42	*
			29	65	55
			30	20	48
			31	14	40
			32	34	60
			33	46	36
			34	30	30
			35	22	48
			36	46	36
			37	40	30
			38	30	32
			39	30	30
			40	30	30
			41	30	30
			42	40	46
			43	48	40
			44	44	42
			45	40	40
			46	60	44
			47	60	58
		W	48	60	60
		W	49	60	60
			50	60	50
			51	*	*
		W	52	34	50

PRIVATE OFFICES AT DESK LEVEL

OFFICE#	f/c	
A106	65	
A107	34	
A108	70	
A109	45	
A110	**	
A111	**	
A112	80	
A113	60	
A114	24	***
A115	80	
A116	30	
A117	60	
A118	55	
A119	55	
A120	35	***
A121	70	
A122A	50	
A122B	NA	
A123	**	
A124	80	
A125	80	
A126	70	
A127	44	
A128	60	
A129	50	
A130	**	
A131	90	
A132	70	
A133	42	
A134	80	
A135	65	
A136	40	
A137	60	
A138	70	
A139	**	
A140	55	
A141	60	
A142	40	
A143	70	
A144	36	
A145	NA	
A146	60	
A147	NA	
A148	**	
A149	**	
A150	NA	
A151	**	
A152	**	
A153	50	
A154	**	
A155	NA	
A156	40	

* SEQ CHGE

A173 na

FOOTCANDLE READINGS

					A174	**
					A175	**
				W	A176	65 NEED 2FT
				W	A177	70
				W	A178	70
				W	A179	90
					A180	80
					A181	40
					A182A	44
					A182B	48
					A182C	80
					A183	52

RA'S 10 A

53	24	22		A157	50
54	14	24		A158	44
55	44	48		A159	40
56	32	44		A160	NA
57	14	18		A161	48
58	14	18		A162	50
59	14	14		A163A	70
60	32	18		A164	46
61	22	40		A165	60
62	50	50		A166	NA
63	40	46		A167	**
64	22	20	W	A168A	70
65	30	40	W	A168B	70
66	22	40	W	A168C	70
67	22	40	W	A169	90
68	48	40	W	A170	90
69	46	42	W	A171	NA
70	44	38	W	A172	90
71	36	48			
72	28	34			
73	14	12			
74	44	60			
75	48	36			
76	50	46			
77	34	32			

AMD 10

A 78	28	48		A302	44
79	*	*		A303	46
80	*	*		A304	46
81	*	*		A305	60
A 82	36	50		A306	55
A 83	38	50		A307	38
84	38	36		A308	NA
85	42	44		A309	48
86	10	20		A310	NA
87 THRU 91 PMD				A311	60
92	*	*		A312	24
93	*	*		A313	**
94	*	*		A314	NA
95	*	*		A315	NA
A 96	30	50		A316	56
A 97	42	50		A317	NA

FOOTCANDLE READINGS

A	98		14	38	A318	20
A	99		36	50	A319	20
	100		30	34	A320	NA
	101		36	30	A321	18
	102		30	32	A322	20
	103		36	30	*SEQ CHG	
	104		36	24	W A328	55
	105		50	50	W A329	60
	106		50	48	A332	LAB
	107		24	46		
	108		35	46		
	109		48	50		
	110		50	50		
	111		46	26		
	112		50	48		
	113		12	48		
	114		48	16		
	115		14	16		
	116		12	28		
	117		28	36		
	118		44	28		
	119		30	34		
	120		24	30		
	121		32	44		
	122		20	42		
	123		26	38		
	124		24	42		
	125		28	38		
	126		36	46		
	127		20	36		
	128		24	34		
	129		36	42		
	130		36	48		
	131		24	28		
	132		36	44		
	133		42	34		
	134		34	42		
	135		26	36		
	136		36	40		
	137		34	40		
	138		22	22		
	139		36	44		
	140		48	44		
	141	A	38	36		
	141	B	24	40		
	141	C	40	*		
	142		28	26		
	143		50	50		
	144		40	49		
	145		22	26		
	146		30	40		
	147		20	30		
	148		24	20		
	149		48	42		
	149	A	40	60		
	150		28	44		
	150	A	30	60		
	151		24	36		

FOOTCANDLE READINGS

	152	38	36				
	153	46	60				
	154	18	42				
W	155	42	48				
W	156	42	60				
	157	60	60				
	158	30	55				
W	159	46	50				
W	160	48	55				
	161	40	36				
	162	12	28				
W	163	26	38				
W	164	48	50				
	165	42	42				
	166	12	40				
W	167	22	42				
W	168	42	40				
	169	44	48				
	170	30	50				
W	171	40	50				
W	172	40	50				
	173	42	50				
	174	42	60				
W	175	36	60				
W	176	46	48				

PMD 10

A	87	70	60		A323	60	
A	88	70	75		A324	NA	
A	89	50	50	W	A325	22	
A	90	55	50		A326	44	
A	91	70	50		*SEQ CHG		
	*SEQ CHG			W	A334	32	
	177	26	50	W	A335	60	
	178	20	40	W	A336	48	***
	179	30	40	W	A337	60	
	180	34	60		A338	NA	
	181	40	38		A339	NA	
	182	30	44		A340	NA	
	183	44	48		A341	NA	
	184	30	24		A342	NA	
	185	60	60		A343	NA	
	186	38	50		A344	NA	
	187	50	48		A345	NA	
	188	26	20		A346	55	
	189	20	18		A347	46	
	190	*	*		A348	55	
	191	*	*		A349	NA	
	192	30	46		A350	NA	
	193	42	36		A351	NA	
	194	42	46	W	A352	60	
	195	42	46		A353	50	
	196	24	34	W	A354	42	
	197	26	34		A355	NA	
	198	28	36		A356	26	
W	199	38	26		A357	50	
W	200	18	20		A358	46	

FOOTCANDLE READINGS

W	201	14	16	
W	202	12	16	
	203	48	46	
	204	50	42	
	205	42	44	
	206	40	42	
	207	18	48	
	208	38	38	
	209	48	46	
	210	*	*	
	211	*	*	
	212	32	46	
	213	38	36	
	214	30	38	
	215	40	50	
	216	28	50	
	217	22	28	
	218	36	24	
	219	36	14	
	220	34	12	
	221	44	38	
	222	38	48	
	223	50	60	
W	224	26	16	
W	225	16	16	
W	226	46	30	
W	227	24	30	
W	228	18	24	
W	229	26	16	
W	230	14	12	
	231	20	42	
	232	48	40	
W	233	44	26	
W	234	40	28	
	235	34	40	
	236	55	46	
W	237	50	30	
W	238	30	26	
W	239	34	40	
W	240	32	36	
	241	48	60	
	242	32	60	
W	243	34	16	
W	244	22	40	
W	245	18	30	
	246	60	60	
	247	50	55	
W	248	50	50	
W	249	36	36	
W	250	60	*	
W	251	60	*	
	252	48	48	
	253	65	60	
	254	35	60	
	255	46	50	
	256	22	16	
	257	48	48	
	258	30	48	
	A359	55		
	A360	NA		
	A361	NA		
	A362	40		
	A363	NA		
	A364	40		

FOOTCANDLE READINGS

	259	50	60
	260	48	50
	261	30	50
	262	60	50
	263	30	42
	264	42	48
W	265	26	50
W	266	40	38
W	267	36	55
W	268	36	46
	269	30	-10
	270	14	-10
	271		
	272		
	273		
	274		
	275		
	276		
	277		
	278		
	279		
W	280	32	32
W	281	36	44
W	282	38	30
W	283	38	42
	284	*	*
	285	55	46
W	286	36	50
W	287	34	30
	288	34	50
	289	38	60
	290	50	50
	291	34	50
	292	40	45
	293	85	50
	294	60	60
	295	38	42
	296	32	46
	297	38	42
	298	50	50
	299	46	34
	300	44	40
	301	48	38
	302	38	48
	303	38	44
	304	48	36
	305	40	48
	306	25	48
	307	50	60
	308	18	28
	309	42	42
	310	46	46
	311	48	28
	312	28	22
	313	20	24
	314	25	18
	315	22	28
	316	50	50

FOOTCANDLE READINGS

	317	45	40		
	318	18	28		
	319	50	42		
	320	18	28		
	321	55	46		
	322	34	34		
	323	40	*		
	324	32	48		
	325	44	65		
	326	28	44		
	327	28	46		
A	328	70	75		
A	329	70	70		
A	330	80	80		
A	331	70	60		
	332	34	70		
	333	34	60		
	334	60	48		
	335	50	60		
A	336	60	70		
A	337	30	46		
A	338	60	70		
A	339	75	75		
	340	30	34		
	341	60	60		
	342	50	50		
	343	50	50		
A	344	70	70		
A	345	75	75		
A	346	65	65		
A	347	65	65	*	
A	348	80	80		

WMD	11				B101	NA
		349	40	*	B102	60
		350	46	*	B103	44
		351	40	60	B104	50
		352	24	60	B105	50
		353	26	70	W B106	38
		354	52	70	B107	NA
		355	30	50	B108	NA
		356	30	50	B109	NA
		357	70	50	W B110	42
		358	24	60	W B111	40
		359	26	60	W B112	60
		360	50	60	W B113	40
		361	60	65	W B114	80
		362	70	65	B115	50
		363	70	80	B116	40
		364	30	80	B117	65
		365	28	80	B118	50
		366	46	80	B119	20
		367	30	55	B120	NA
		368	60	50	B121	NA
		369	55	60	B122	NA
		370	55	34	B123	NA
		371	20	65	B124	40

FOOTCANDLE READINGS

	372		55	70	B125	42
W	373		36	20	B126	50
W	374		40	26	B127	-10
W	375		30	26	W B128	50
W	376		20	16	W B129	42
W	377		20	14	W B130	38
	378		50	50	W B131	48
	379		55	48	B132	NA
	380		28	40	B133	50
A	380	A	90	80	B134	28
	381		60	60		
	382		32	60		
	383		34	50		
	384		44	38		
	385		24	50		
	386		40	50		
	387		44	46		
	388		50	50		
	389		60	60		
	390		60	50		
	391		36	50		
	392		28	42		
	393		32	38		
	394		42	38		
	395		26	38		
	396		50	60		
	397	A	12	*		
	397	B	14	*		
	397	C	16	*		
	398		48	50		
	399		50	60		
	400		28	44		
	401		44	42		
	402		44	46		
	403		30	46		
	404		48	*		
	405		48	*		
	406		30	44		
	407		44	46		
	408		42	30		
	409		28	40		
	410		46	*		
	411		48	*		
	412		30	42		
	413		42	44		
	414		42	44		
	415		30	30		
	416		46	60		
	417		48	60		
	418		32	46		
	419		44	46		
	420		44	44		
	421		30	42		
	422		44	48		
	423		32	42		
	424		46	44		
	425		70	65		
	426		70	50		

FOOTCANDLE READINGS

W	427	34	50
W	428	48	50
	429	44	70
	430	48	65
W	431	42	60
W	432	34	55
	433	34	60
	434	40	70
W	435	36	60
W	436	36	48
	437	48	60
	438	48	60
W	439	42	55
W	440	42	60
	441	60	46
	442	44	50
W	443	50	44
W	444	34	50
W	445	55	32
W	446	44	60
W	447	36	50
	448	38	70
	449	46	70
W	450	28	55
W	451	34	50
	452	48	60
	453	38	50
W	454	42	48
W	455	34	60
	456	36	70
	457	65	50
W	458	34	55
W	459	44	55
	460	50	70
	461	30	60
W	462	48	50
W	463	36	50
	464	36	46
	465	50	70
	466	34	55
	467	44	60
	468	30	44
	469	30	28
	470	48	30
	471	44	44
	472	48	48
	473	42	36
	474	38	30
	475	10	24
	476	12	26
	477	12	24
	478	30	38
	479	36	*
	480	36	44
	481	32	46
	482	34	42
	483	38	42
	484	40	*

FOOTCANDLE READINGS

485	30	*
486	20	34
487	40	42
488	22	28
489	32	32
490	24	40
491	24	34
492	40	36
493	40	32
494	34	44
495	42	44
496	28	40
497	22	40
498	50	42
499	25	*
500	38	38
501	22	40
502	24	42
503	38	40
504	46	*
504	50	*
506	26	*
507	46	44
508	38	38
509	26	28
510	32	28
511	22	30
512	48	38
513	32	38
514	34	46
515	34	20

OIG 11

W	516	60	40	W B135	55
W	517	44	*	B136	42
W	518	46	60	B137	30
W	519	44	44	B138	44
W	520	40	48	B139	NA
W	521	34	50	B140	75
	522	48	50	B141	NA
	523	30	38	B142	NA
	524	34	60	B143	65
	525	48	38	B144	30
	526	46	48	B145	NA
	527	38	44	B146	44
	528	42	22	B147	NA
	529	55	46	W B148	65
	530	55	48	B149	60
	531	32	40	B150	44
	532	36	50	B151	70
	533	65	50	B152	NA
	534	36	34		
	535	10	26		
	536	65	65		
	537	55	55		

FOOTCANDLE READINGS

NEIC 11

	W	W10	48	48		
	W	W11	48	48	W B153	60
		W12	44	44	B154	NA
		W13	44	44	B155	NA
		W14	44	44	B156	NA
		W15	42	46		
		W16	42	42		
		W17	42	42		
		W18	50	48		

---

11 SPECIAL PURPOSE AREAS

TI		538	40	32	W B156A	NA
		539	20	*	W B157	NA
		540	24	*	B158	NA
		541	28	*		
		542	24	*		
LIB	A	543	42	40	A B162	60
	A	544	50	70		
	A	545	45	50		

"A" PRECEEDING W/S OR OFFICE DESIGNATES IN ATRIUM
"W" PRECEEDINGW/S OR OFFICE DESIGNATES ON A WINDOW
* DESIGNATES NO WORKSURFACES OR NOT REQUIRED
** W/S OR OFFICE NOT ON PLANS
*** BULBS REMOVED TO CUT BACK LIGHT

2/20/91